

# CONCRETE

## AND

### CONSTRUCTIONAL ENGINEERING

JUNE, 1951.



Vol. XLVI, No. 6

FORTY-SIXTH YEAR OF PUBLICATION

PRICE 1s. 6d.

ANNUAL SUBSCRIPTION 15s., POST FREE. \$3.90 in Canada and U.S.A.

#### LEADING CONTENTS

	PAGE
Labour in the Construction Industry . . . . .	163
A Concrete-Lined Tunnel in Scotland . . . . .	165
Beams with Variable Moment of Inertia.—I. <i>By B. Eriksen.</i>	177
Continuously-Reinforced Concrete Roads . . . . .	182
A Canal Cover and Culvert at Cardiff . . . . .	183
Test of a Prestressed Concrete Railway Bridge . . . . .	186
A Pipe Bridge in Italy . . . . .	188
Prestressed Bridges in the U.S.A. . . . .	192

No. 528

ISSUED MONTHLY

Registered for  
Canadian Magazine Post

#### BOOKS ON CONCRETE

For catalogue of "Concrete Series" books on concrete and allied subjects, send a postcard to:

CONCRETE PUBLICATIONS LTD., 14 DARTMOUTH ST., WESTMINSTER, S.W.1



*For over 60 years*

this trade mark has stood for speed and  
strength in reinforced concrete work.

# DRAGON

(Brand)

## PORTLAND CEMENT

*Supplied by*  
THE SOUTH WALES PORTLAND CEMENT & LIME CO. LTD.  
PENARTH, SOUTH WALES

Telephone : Penarth 300

Telegrams : "Cement, Penarth"

# Burton's

(SAFETY LOCK—UNIQUE FEATURE)

## TUBULAR STEEL PROPS

(ADJUSTABLE)

*For Supporting Temporary Floor Shuttering*

### Burton's Adjustable Tubular Steel Props

for the above and many other purposes, are much preferred by the men who erect them to the old-fashioned Timber Props. They can be erected by one man in a few minutes and positively adjusted and safely locked in position, thus avoiding any possibility of being accidentally or maliciously tampered with.

*Manufactured in our own most modern and up-to-date works at Old Hill, Staffs.*

No spanner, jack, or tommy bar necessary; simply lift inner tube, insert peg, and tighten up.

*No loose parts to lose, and easily transported.*

### BURTON'S ADJUSTABLE TUBULAR STEEL BEAM PROPS

are provided, as illustrated, with a braced head for supporting temporary shuttering to R.S.J. casings and reinforced concrete beams, &c.



Size No.	HEIGHT		Approx. Weight each in Lb.
	Fully Closed	Fully Extended	
1.	5 ft. 7 in.	9 ft. 10 in.	50
2.	6 ft. 7 in.	10 ft. 10 in.	54
3.	8 ft. 2½ in.	12 ft. 5½ in.	58
4.	11 ft. 0 in.	16 ft. 0 in.	72

*Head Fittings to suit any Special Job, designed for use with BURTON'S PROPS.*

## Burton's Patent Solid Dropforged Steel Scaffolding Fittings

## THE LONDON & MIDLAND STEEL SCAFFOLDING CO., LTD.

ST. LUKE'S WORKS, OLD HILL, STAFFORDSHIRE

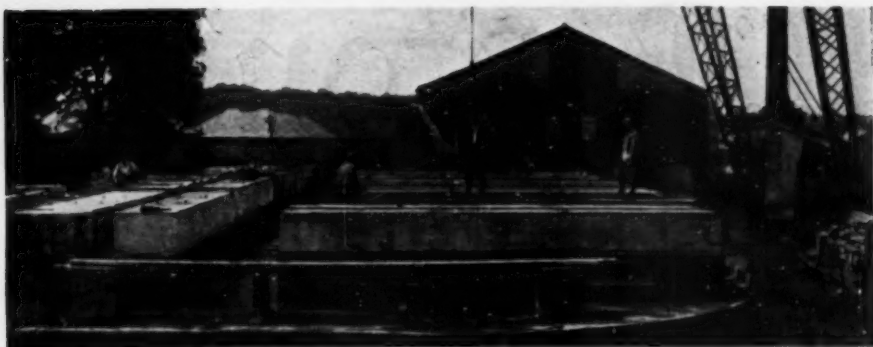
Telegrams: DUBELGRIP, CRADLEY HEATH.

Telephone: CRADLEY HEATH 6237/8

London Offices: BURWOOD HOUSE, CAXTON STREET, S.W.1

Telephone: Abbey 6483/4

Telegrams: Dubelgrip, Sowest, London



**precast  
concrete  
beams**

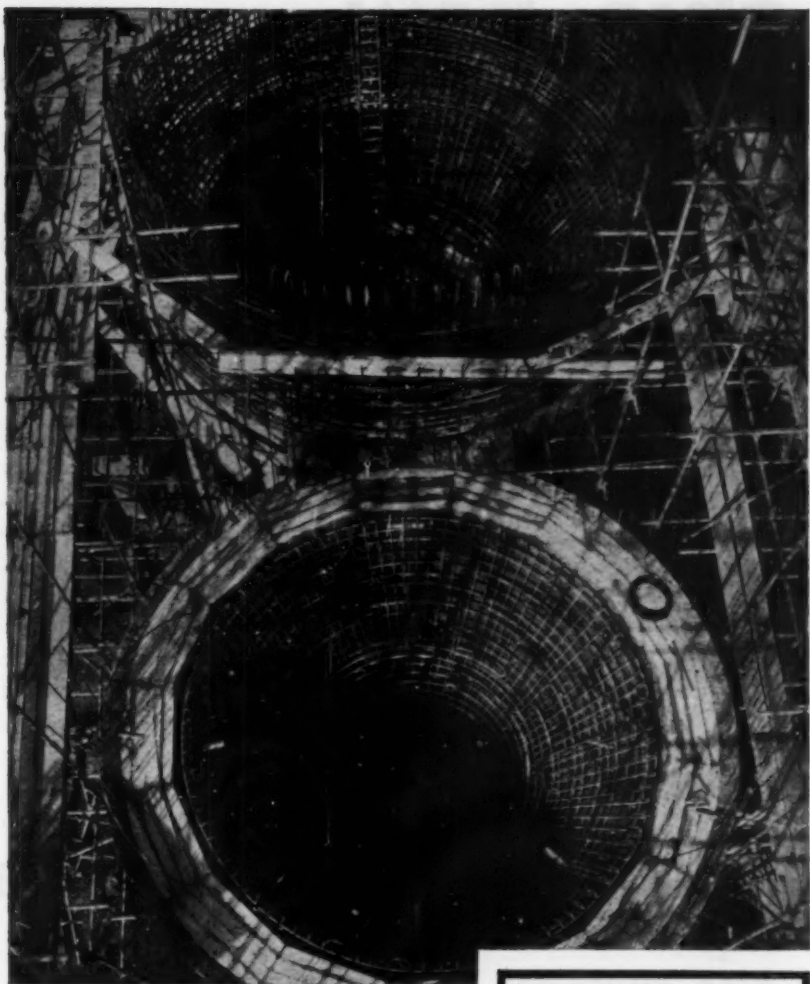
24 ft. LONG, 3 ft. 4 in. WIDE and 2 ft. 2 in. DEEP  
for covering 1,700 ft. of a canal for the new dual-carriageway  
at Churchill Way, Cardiff. City Surveyor : Mr. E. C. Roberts,  
M.Eng., M.Inst.C.E.

manufactured by  
**BRITISH FRAM**  
**CONSTRUCTION CO. (1911) LTD.**

**Specialists in all forms  
of precast concrete**

We offer a first-class experience in precast concrete work, and invite inquiries for units of all sizes and designs for large or small contracts. Include our name on your list for future inquiries.





*Consulting Engineers: Oscar Faber and Partners*

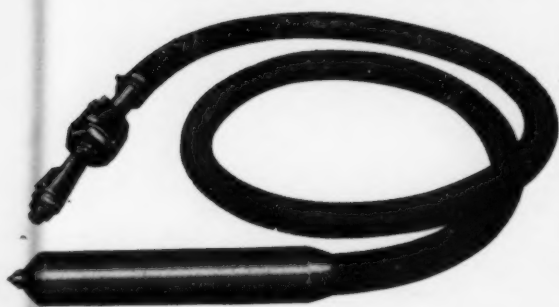
### **Reinforced Concrete Construction**

Two of a group of four preliminary mixers under construction at the Cement Works at Shoreham, Sussex, for the British Portland Cement Manufacturers Limited.

**LAING**

**Contractors for every class of Building and Civil Engineering work at home and overseas**  
*John Laing and Son Limited, London, Carlisle, Johannesburg, Lusaka. Established in 1848*

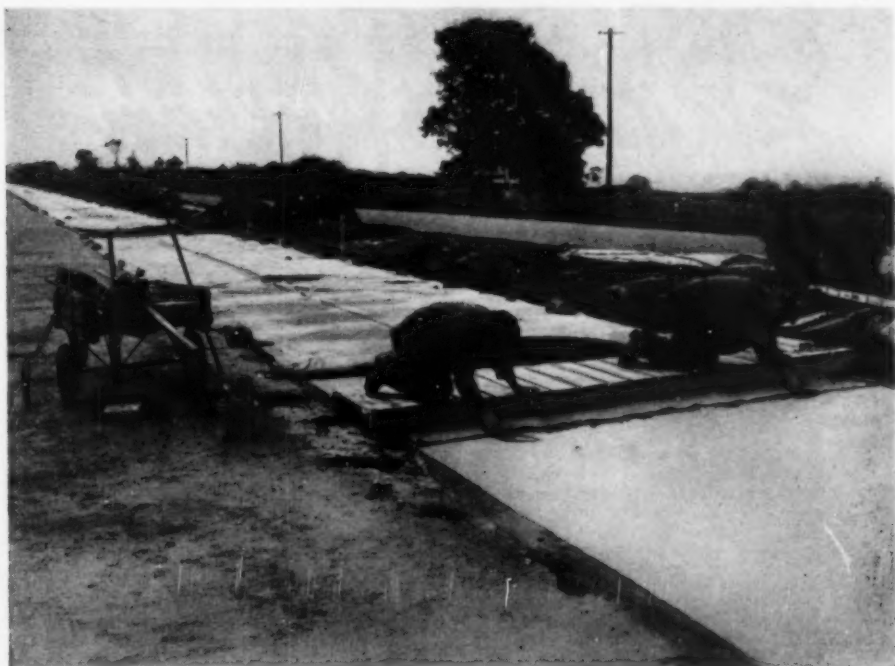
# ★ this new improved pneumatic vibrator



is different because it is better. It is better because its up-to-date design incorporates new features which enable a high degree of efficiency in vibrating dry and harsh concrete to be carried out with ease of handling and operation. It provides variable frequency and is fitted with a speed regulator. It starts instantly, will not freeze, and works with undiminished frequency and "punch" for any length of time. The special heat-treated steel of the cylinder and toe-piece provides a special wear-resisting surface which prolongs its life. A rubber toe-piece, to prevent possible damage to the shuttering, can be supplied if required. All Engineers and Contractors interested in improved methods of concrete vibration are invited to send for full details and specification. Free working demonstrations can be arranged on application to:

## COMPACTORS ENGINEERING LTD

**also suppliers of electric immersion  
vibrators • vibrosoil compactors •  
trench compactors • S.G.M.E. vibro-finishers  
joint cutters and distributors •  
hydraulic bar croppers and bar benders**



The ancient Fosse Way, running north from Leicester, existed merely as a drift way up to 1923. About that time the County Council lightly metalled it to provide a hard two-lane carriageway which did service for several years, but since it affords the most direct route from Leicester to Nottingham as well as to Lincoln and the North East, some modern reconstructional treatment was inevitable. This work was interrupted by the War, and from 1943 to 1945 one of the carriageways on a "dual" section of the road was used as a park for military vehicles.

This carriageway began to fail after the War and had to be reconstructed. Owing to the extent of the job and a dearth of labour, up-to-date mechanical methods were necessarily employed and included mechanical spreaders and finishers and a travelling mixer.

Curing and protection, as might be expected, was entrusted to SISALKRAFT Concrete Curing Blankets placed directly on the concrete as soon as practicable after the last pass of the finishing machine. The picture is published by kind permission of the local highway authority by whom the project was carried out with direct labour.

- ★ Technical information and sample section of the New Improved SISALKRAFT Concrete Curing Blanket on request.

Sole Distributors for British Sisalkraft Ltd.

**J.H. SANKEY & SON, LTD.**

**SISALKRAFT**  
TRADE MARK

ALDWYCH HOUSE, ALDWYCH, LONDON, W.C.2. Telephone: Holborn 6949. Telegrams: Brickwork, Estrand, London

# Take it up with Wickham

**WICKHAM Builders' Hoists**, all models, include quick fitting Tower Masts which take substantially less time to erect. The Mast sections are designed to butt on to each other and so rabbeted as to be automatically self-aligning. Sections are held together by six bolts only, no fish plates being required. The Power unit is totally enclosed in a steel housing affording complete protection. All Wickham Friction Winches are fitted with self-aligning ball and/or roller bearings, giving longer life and lower maintenance costs. All Wickham Builders' Hoists are fitted with an Automatic platform control which increases the life of the wire bond and prevents crashed platforms.

**Leading Contractors on the Festival of Britain sites made extensive use of WICKHAM BUILDERS' HOISTS**

## WICKHAM PRODUCTS

**Builders' Hoists (Mobile and Static), Passenger Hoists, Concrete Elevators, Diaphragm Pumps, Power Winches, Portable Winches, Brick Barrows, Safety Gates**



*Please write to us for interesting literature and the name of our agent in your area.*

TAKE IT  UP WITH

# Wickham

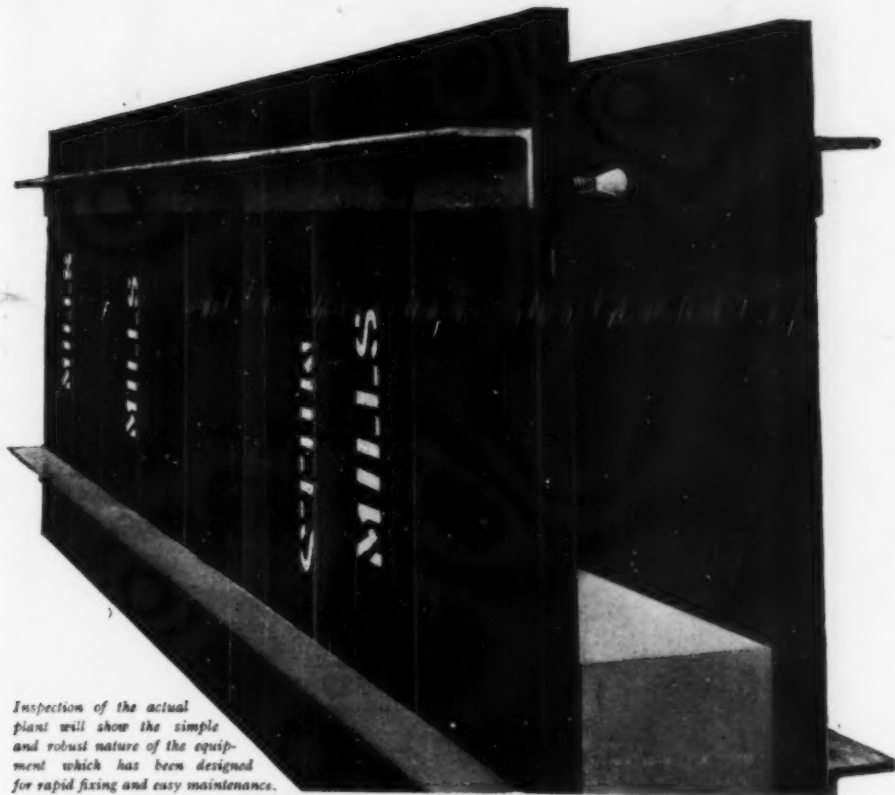
**WICKHAM  
ENGINEERING CO. LTD.**

(Dept. 4) 34 VICTORIA ST., LONDON, S.W.1. Phone: ABBEY 5967-8

Grams: Wicamite Sowest London

# MILFORMS

**FOR AUTOMATIC ALIGNING AND  
SELF-SUPPORTING SHUTTERING TO  
WALLS, FLOORS, COLUMNS AND BEAMS, ETC.**



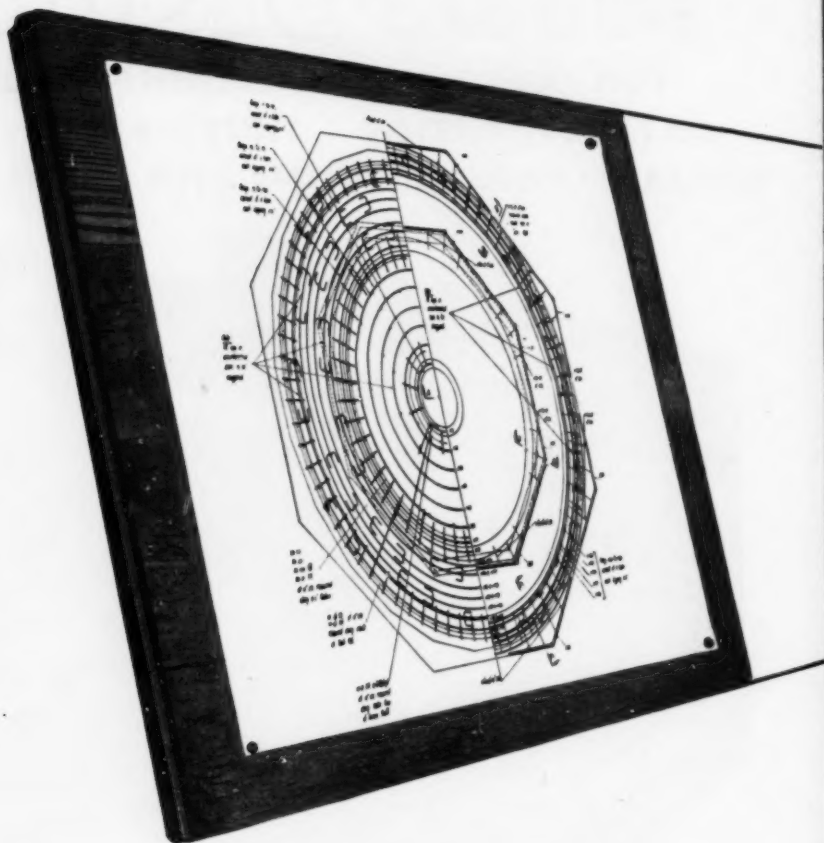
*Inspection of the actual plant will show the simple and robust nature of the equipment which has been designed for rapid fixing and easy maintenance.*

**This new range of formwork, for use on all types and systems of concrete construction, provides the Contractor with the means of overcoming formwork difficulties in an easy and economical way. No special tools are required, it is easy to erect and dismantle, and robustly constructed to withstand heavy wear. Full information can be obtained from any Mills Depot.**

**MILLS**  
**SCAFFOLD CO., LTD.**

BELFAST • BIRMINGHAM • BOURNEMOUTH • BRIGHTON • BRISTOL  
CANTERBURY • CARDIFF • COVENTRY • CROYDON • DUBLIN  
EXETER • GLASGOW • HULL • ILFORD • LIVERPOOL • LOWESTOFT  
MANCHESTER • NEWCASTLE • NORWICH • PLYMOUTH  
PORTSMOUTH • SOUTHAMPTON • SWANSEA • YARMOUTH

**Head Office & Depot: TRUSSLEY WORKS, HAMMERSMITH GROVE, LONDON, W.6. Tel: RIVerside 5026/9**



# BRC

brings the accuracy of  
the drawing board to the job

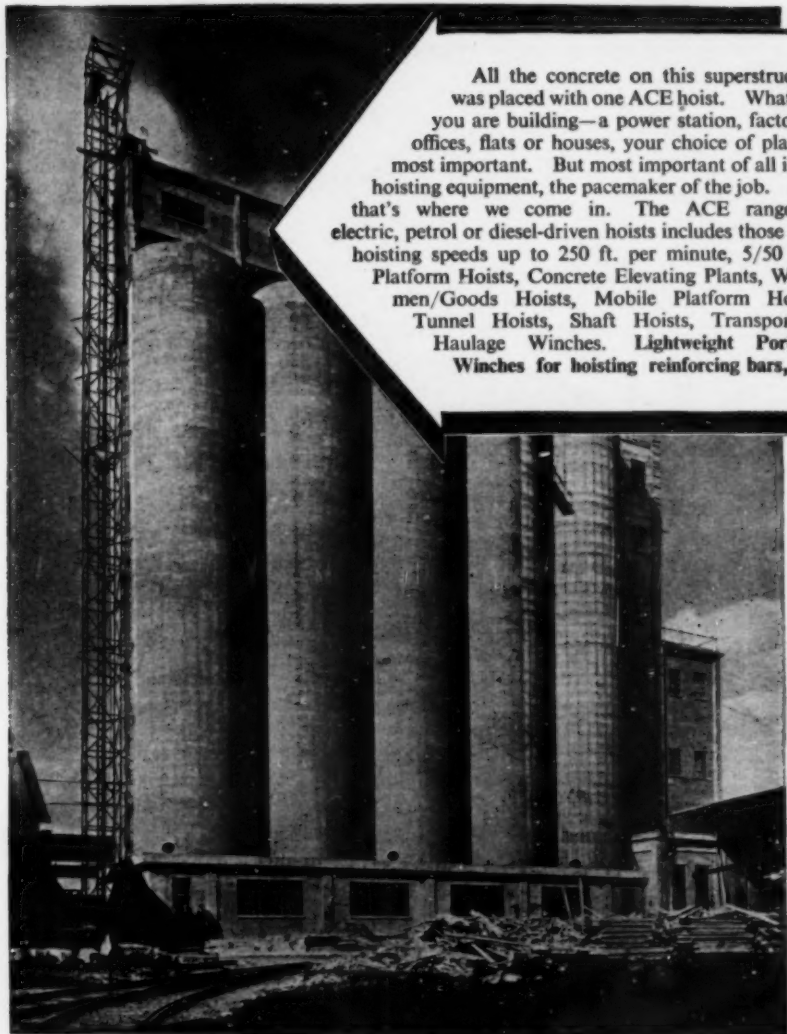
*Issued by* **THE BRITISH REINFORCED CONCRETE ENGINEERING CO. LTD., STAFFORD**  
*Specialists in Reinforced Concrete Design & Suppliers of Reinforcement*  
*London, Birmingham, Bristol, Leeds, Leicester, Manchester, Newcastle, Sheffield, Cardiff,*  
*Glasgow, Dublin, Belfast*

---





M-W-593



All the concrete on this superstructure was placed with one ACE hoist. Whatever you are building—a power station, factories, offices, flats or houses, your choice of plant is most important. But most important of all is the hoisting equipment, the pacemaker of the job. And that's where we come in. The ACE range of electric, petrol or diesel-driven hoists includes those with hoisting speeds up to 250 ft. per minute, 5/50 cwt. Platform Hoists, Concrete Elevating Plants, Workmen/Goods Hoists, Mobile Platform Hoists, Tunnel Hoists, Shaft Hoists, Transporters, Haulage Winches. **Lightweight Portable Winches for hoisting reinforcing bars, etc.**

**FOR ALL TYPES OF BUILDING CONSTRUCTION**

use

**ACE**

hoists

PLATFORM HOISTS WINCHES

**Sale or Hire**



**A.C.E. MACHINERY LTD., Porden Road, Brixton, London, S.W.2**  
and at Brentford.

Telephone : Brixton 3293 (9 lines)



# prestressed concrete beams for bridge construction

Illustrated above are the 48 ft. prestressed concrete beams manufactured by us to the order of John Lysaght Ltd. for a bridge at their Normanby Park Works. This bridge was recently tested under a load of about 100 tons. The maximum deflections were only 0.019 in. under the parapet and 0.02 in. at the centre.

## **COSTAIN CONCRETE CO. LTD**

DOLPHIN SQUARE, LONDON, S.W.1

WORKS AT BRIDGEND, GLAMORGAN

CHILDERDITCH, ESSEX

VICTORIA 6624

COLTNESS, LANARK

# GUNITE AND CEMENTATION



★ Systematic repairs to structures based on systematic diagnosis of defects.

## WHITLEY MORAN & CO. LTD.

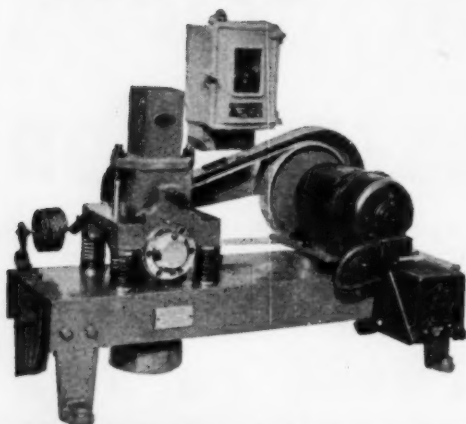
*Specialists in the Repair of Engineering Structures*

**GUNITE**

5 OLD HALL STREET, LIVERPOOL.

Telephone: Central 7975

# "CAPCO" H. F. VIBRATOR



for compacting mortar cubes for Compression Test B.S. 12/1947, B.S. 915/1947, B.S. 146/1947, B.S. 1370/1947 with automatic time control device. The vibrator illustrated in the B.S. was built in our works.

The "CAPCO" range of concrete testing apparatus also includes Cube Moulds; Slump Cones; Tensile, Vicat, and Cylindrical Moulds; Tile Abrasion Machines; Compacting Factor Apparatus.

Full details on request.

## CAPCO (SALES), LTD.

BEACONSFIELD ROAD, LONDON, N.W.10. Telephone: WILLESDEN 0067-5. Cables: CAPLINKO, LONDON

(Sole Agents for all  
"Capco" Products)

**REINFORCED  
CONCRETE  
ROADS*****Cheapest in the  
long run***

Architect : R. Lewis Reynish,  
A.R.I.B.A.  
Contractors : Warings (Con-  
tractors), Ltd.

**WITH****REINFORCEMENT BY****McCALL'S**

Road at Greenwood Avenue,  
Portsmouth, for Mr. John Day,  
South Wymering Farm, Ports-  
mouth, in which McCall's  
Matobar welded fabric rein-  
forcement was used.

**McCALL AND COMPANY (SHEFFIELD) LIMITED**  
TEMPLEBOROUGH, SHEFFIELD • and at LONDON

SRB\_37

# SUPER CEMENT

**'SUBMARINE BRAND'**

THE TANNO-CATALYSED PORTLAND CEMENT

**SAVES TIME**

**SAVES TROUBLE**

NATURALLY WATERPROOF. CONTAINS NO WATER REPELLENT MATERIAL

Uses:—

**For CONCRETE**

Provides a CONCRETE of great strength at early dates and impervious to water, oil, etc., without any form of surface coating.

**For PAVING**

Produces a hard wearing PAVING, dustless and proof against penetration by water, etc.

**For RENDERING**

Supplies an impenetrable RENDERING of such adhesive power that a 1" thickness will resist an outside pressure of at least a 20' head of water.

**For SLURRY (as paint)**

Makes a perfectly watertight covering to brick or breeze concrete walls at very small cost, and also provides the best watertight undercoat to coloured finishes.

Technical Information is available to users.

Used in 1914-1918 and still used by:

Air Ministry, War Office, Admiralty, Ministry of Works, Ministry of Supply, etc.

**SUPER CEMENT LTD.,** 29 TAVISTOCK SQUARE, LONDON, W.C.1 Phone: Euston 1808



**PIN YOUR FAITH  
TO THE TESTED  
BRAND.**

THIS LABEL ON  
EVERY BARREL  
CARRIES WITH IT  
FORTY YEARS'  
EXPERIENCE OF  
MANUFACTURE.

**NONE OTHER IS  
"JUST AS GOOD"**

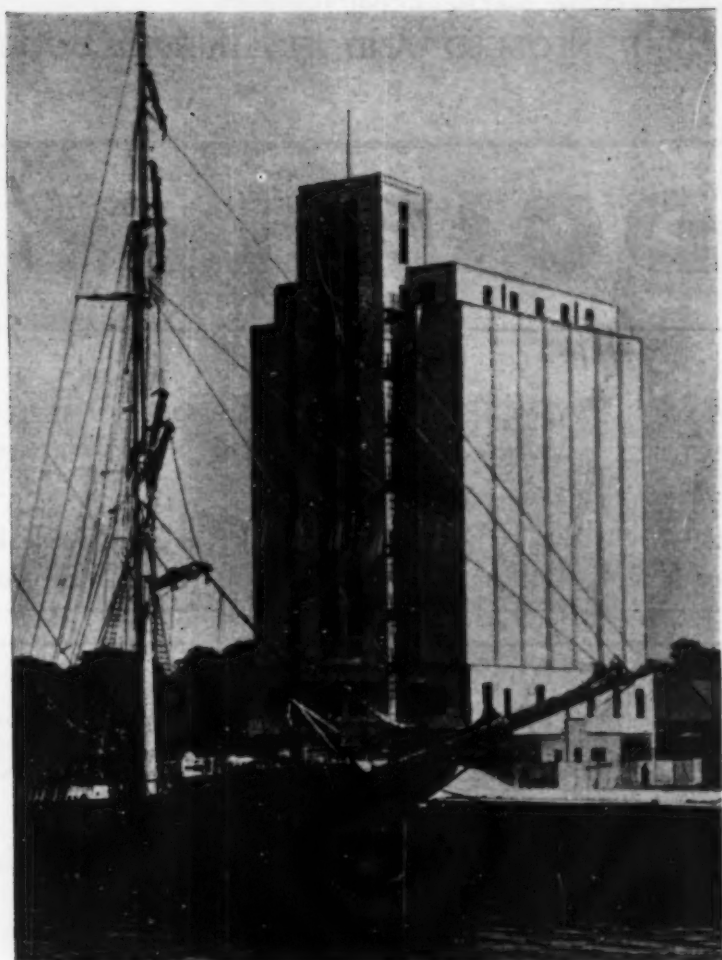
**THE LEEDS OIL & GREASE CO.**

'Phone: 22480.

**LEEDS**

'Grams: "Grease."





GRAIN SILO

IRELAND

# PETER LIND & CO LTD

STRATTON HOUSE, STRATTON STREET, PICCADILLY, W.1

TELEPHONE:

GROSVENOR 4601 (10 LINES)

BUILDING AND CIVIL ENGINEERING  
REINFORCED AND PRESTRESSED CONCRETE

# DOUGLAS

PILING • HEAVY FOUNDATIONS • ROADS • BRIDGES • AIRFIELDS  
Factories • Sewers • Railways • Bunkers • Cofferdams

ROBERT M. DOUGLAS (CONTRACTORS) LTD.

395 GEORGE ROAD, BIRMINGHAM, 23

Telephone : Birchfields 4541

## MODERN BUILDING EXHIBITION

LITTLE ROODEE, CHESTER

June 22nd — 30th

FOR BUILDERS



ARCHITECTS



ENGINEERS



An Exhibition and Plant Demonstration occupying more than 150,000 sq. ft. and showing the latest developments in building techniques, and new plant and equipment for the builder. Presented by the Ministry



of Works in association with the manufacturers of plant and modern building equipment, this Exhibition is of practical interest and real value to everyone connected with the building industry.

OPEN 10.30 a.m. to 8 p.m. - Admission 1/-

**HEAD OFFICE**

50 Epping New Road,  
Buckhurst Hill, Essex.  
Tel. : Buckhurst 4444  
(13 lines).

**LONDON OFFICE**

47 Victoria Street,  
Westminster, S.W.1.

**BRANCH OFFICES****ROMFORD**

217 Brentwood Rd.,  
Romford.  
Tel. : Romford 2828.

**WISBECH**

South Brink, Wisbech.  
Tel. : Wisbech 1530.

**COLCHESTER**

Ipswich Rd., Dedham,  
near Colchester.  
Tel. : Dedham 3133.

**KENYA**

P.O. Box 651,  
Nairobi, Kenya.

Lighterage and Wharfage  
facilities on River Lea

**BRICKFIELDS AT:**

Chigwell Rd., S. Woodford,  
E.18. Tel. : Buckhurst 1276.

Luxborough Lane, Chigwell.  
Tel. : Buckhurst 5833.

Ongar, Essex  
Tel. : Ongar 48

Makers of Stock Bricks,  
Facing Bricks, Roof Tiles,  
Land Drains, and other  
clay products.

**TRANSPORT & PRE-CAST CONCRETE DEPT.**

North Farm, Loughton,  
Essex.  
Tel. : Loughton 480.

Contractors for :  
Air Ministry, London  
County Council, Railway  
Executive British Railways,  
Catchment Boards, London  
Transport Executive,  
Colne Valley Sewage Bd.,  
Middlesex County Council,  
East Middx. Main Drainage,  
and other Authorities.



Construction of the Incinerator House, Coal Bunkers, Filter House and Conditioner House for the Colne Valley Sewage Board.

Consulting Civil Engineers : Sandford Fawcett and Partners, Westminster, S.W.1.

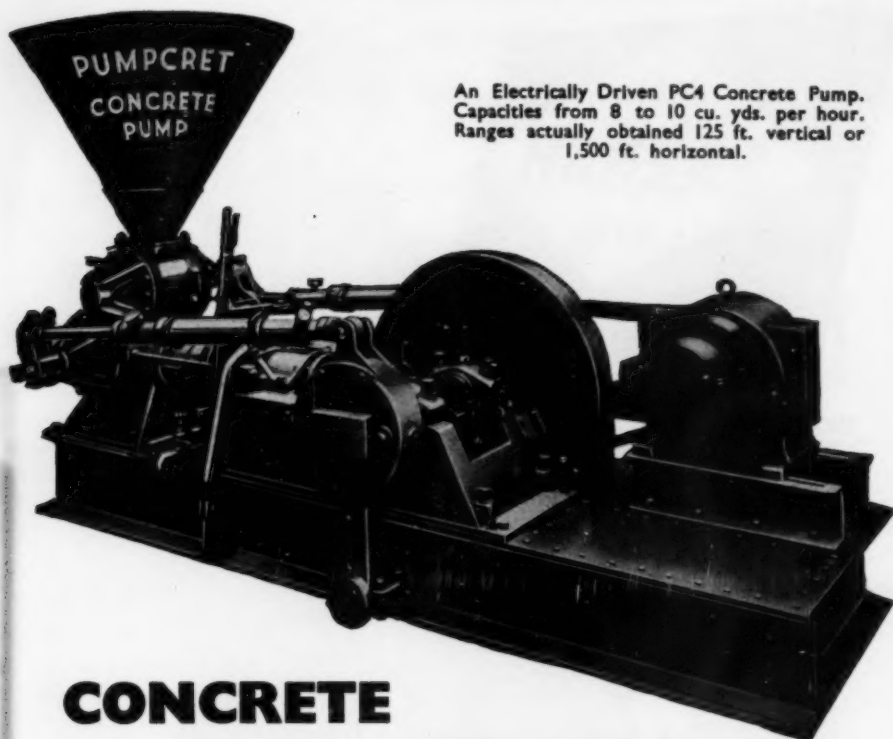


Construction of an underline bridge at Leytonstone.

County Surveyor and Engineer :  
H. J. Berry, M.I.C.E.,  
M.Inst.M.E., Chelmsford,  
Essex.

Engineers for the work :  
Rendell Palmer and Tritton,  
Chartered Civil Engineers, 125  
Victoria Street, Westminster,  
S.W.1.





An Electrically Driven PC4 Concrete Pump.  
Capacities from 8 to 10 cu. yds. per hour.  
Ranges actually obtained 125 ft. vertical or  
1,500 ft. horizontal.

## CONCRETE BY PUMP AND PIPELINE

- The latest and most efficient method of placing concrete.
- Pump and Mixing plant can be located where it is most convenient for storing and handling aggregates and cement.
- The concrete is delivered by pipeline just wherever it is required with the minimum of interference with the building operations.
- The speed of the pump governs the whole of the concreting gang.
- Pumpable concrete must of necessity be good concrete.

**THE CONCRETE PUMP COMPANY LTD**

**4 STAFFORD TERRACE, LONDON, W.8**

Telephone: Western 3546.

Telegrams: Pumpcret, Kens, London.



Bridge erected by us at the Normanby Park Works of John Lysaght's Scunthorpe Works, Ltd., using prestressed precast concrete beams. Designed by Twisteel Reinforcement, Ltd.

# reinforced concrete by



THE  
**DEMOLITION &  
CONSTRUCTION**  
CO. LTD

3 ST. JAMES'S SQUARE • LONDON • S.W.1

Telephone : TRAFALGAR 7833

# CONCRETE PROOFING Co. LTD.

# GUNITE SPECIALISTS

Expert advice and schemes submitted for gunite work of every kind. Complete information on the various uses of gunite will be gladly sent on request.

100, Victoria Street, Westminster, S.W.1

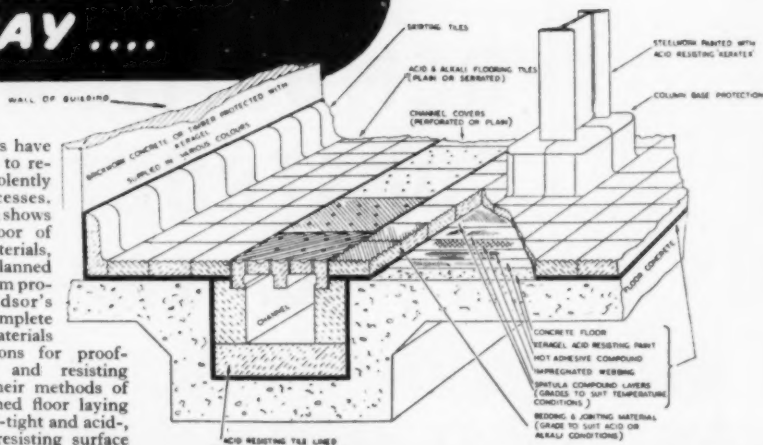
Telephone:

VICTORIA 7677 and 6276

## KEEPING CORROSION AWAY ....

Industrial floors have to be designed to resist the most violently corrosive processes. The illustration shows a five-layer floor of Windsor's materials, scientifically planned to give maximum protection. Windsor's produce a complete range of materials and preparations for proofing concrete and resisting corrosion. Their methods of carefully planned floor laying ensure a liquid-tight and acid-, alkali- or oil-resisting surface without repair.

Details and advice on any problem are gladly given.



## H. WINDSOR & CO. LTD.

748 FULHAM ROAD, S.W.6. Telephone: RENown 6006/7/8  
119 VICTORIA STREET, S.W.1. Telephone: VICToria 9331/2



# MONK

OF

## WARRINGTON & LONDON

*are organised and equipped  
to carry out*

REINFORCED CONCRETE  
CIVIL ENGINEERING  
& BUILDING CONSTRUCTION

*This organisation has been  
responsible for the construction of many  
major projects at Home and Overseas*

### **A. MONK & COMPANY LIMITED**

*Head Office :*  
*Padgate, Warrington*  
*Tel: Warrington 2381*

*London Office :*  
*75, Victoria Street, S.W.1*  
*Tel: Abbey 2651*

# MOULD OILS & COMPOUNDS

for every process of  
concrete production

## CONCREAM

This non-staining, smooth and easy working white mould oil can be used with confidence on all classes of in situ and precast concrete work where the use of a white mould oil is recommended.

## VIBRAMOL

This non-staining and non-separating mould oil is made specially for use on steel shuttering and moulds where vibrators are used, and provides a good film which is not readily moved under vibration.

## SPRAYMOL

This grade of mould oil has been specially produced for use with a spray gun. It can be used with great economy on all types of shuttering and moulds, and will not separate under pressure.

## "P.S."

Experience has shown that the production of precast and in situ prestressed concrete needs a special mould compound, and in collaboration with leading prestressed specialists we have produced Grade "P.S." Mould Compound for this class of work.

## "8.A."

This Mould Compound has been specially produced to satisfy the requirements of those engaged in the production of spun concrete products.

CONCREAM<sup>Regd.</sup>  
VIBRAMOL<sup>Regd.</sup>  
SPRAYMOL<sup>Regd.</sup>  
"P.S." & "8.A."

### PRODUCTS OF THE ORIGINAL MAKERS OF CONCRETE MOULD OILS

We specialise in the production of mould oils and compounds for concrete work of every kind, from mass concrete work to high-class architectural stone work, and have an unrivalled experience which enables us to give expert advice on all mould oil problems. We have a grade for every purpose, and will be pleased to submit full details, samples, and prices on request.

**RICH<sup>d</sup> HUMBLE & SON, LTD., COLUMBA OIL WORKS, LEEDS, 3**

Telephone : 27155.

ESTABLISHED 1854.

Telegrams : "Columba, Leeds, 3."



**Reinforcement**  
by  
**T.C. Jones & Co. Ltd**  
REINFORCEMENT ENGINEERS - STRUCTURAL ENGINEERS

WOOD LANE, LONDON, W 13 Phone 346 2222 **500** BUTTE STREET, CARDIFF - TREDEGAR, GLAM.

# KWIKFORM



*... the two-component  
Suspended Formwork system .*



The Spanform is a sturdily constructed telescopic unit designed to obtain the utmost economy in usage and maintenance. All "Kwikform" Formwork is available for hire or outright purchase. Fully descriptive literature is available on application.

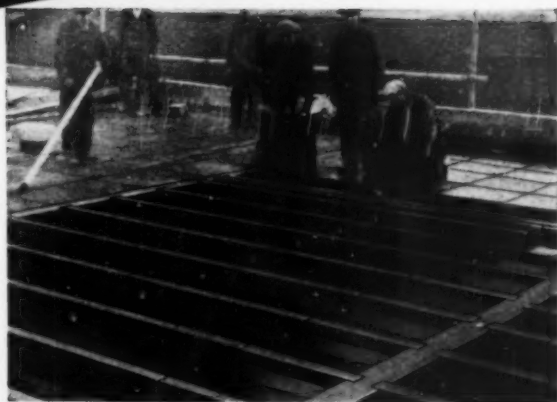
("KWIKFORM" is the registered trade name of  
KWIKFORM LTD.)

KWIKFORM LTD., WATERLOO ROAD, BI

M



Illustrating the simplicity of laying the Platforms which by their design are held rigidly in position. Striking is equally simple.



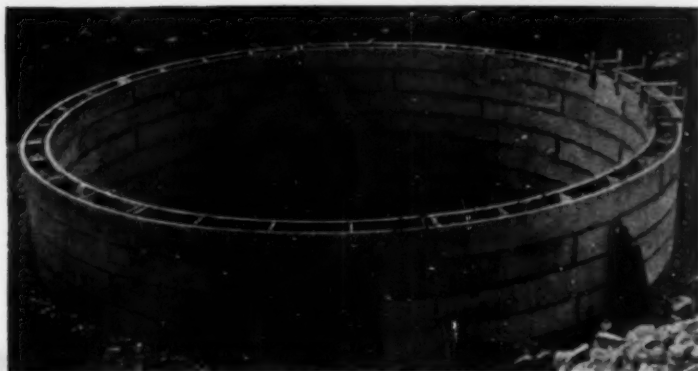
A feature of the Kwikform system is that within the ranges of the standard size Spanforms no props are needed for normal requirements.



MINGHAM 25.

London Office: 66, Victoria Street, S.W.1

L.G.B.



**LOCH  
FANNICH  
HYDRO  
ELECTRIC  
WORKS**

Consulting Engineers : Sir Alexander Gibb & Partners.  
Contractors : Balfour, Beatty & Co., Ltd.

**precast segments**

for the upper part of the surge shaft for the  
tunnel at Loch Fannich Hydro Electric Works  
were

*manufactured by*

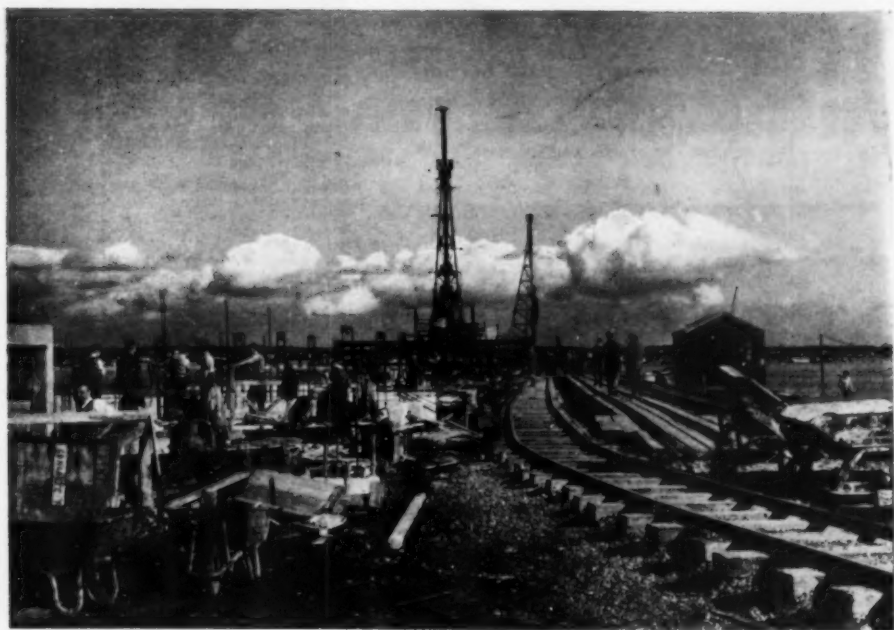
**PRICE & CO.**  
(GLASGOW) LTD.

**SPECIALISTS IN  
REINFORCED CONCRETE  
AND PRECAST CONCRETE**



# **CHRISTIANI & NIELSEN LTD**

## **REINFORCED CONCRETE**



**54 VICTORIA STREET,**

**LONDON, S.W.1**

TELEPHONE: VICTORIA 6152



*It was Shakespeare who wrote : " the purest treasure mortal times afford, Is spotless reputation." To others, treasure merely conjures up a picture of gold and jewels found on desert islands. But, in fact, treasure is anything of real service to mankind. Consider therefore the innumerable uses of Expanded Metal which impinge upon the daily round of work and leisure, almost from the cradle to the grave.*

*Seen or unseen it does its job. In the structure of a building, as reinforcement for concrete, or as a background and " key " for plaster ceilings and partitions. Visible uses include guards for machinery, windows, etc., surrounds to lift shafts, openwork flooring and partitions.*

*In schools, homes, public buildings, shops, factories, offices, cinemas and theatres, there are constant reminders of the ever-increasing value of Expanded Metal Products for a hundred and one uses.*



*Above : " Expamet " Expanded Metal for Railings at Valley Road Schools, Sunderland. Architect : Harvey C. Bishop, Esq., A.R.I.B.A.*

*Below : " Ribmet " as permanent centering for concrete " shell " Domes for Tyne Tunnel Escalator Buildings. Consulting Engineers : Messrs. Mott, Hay and Anderson. Consulting Engineer for Domes : C. V. Blumfield, Esq. Contractors : Messrs. Pardie, Lumsden & Co., Ltd.*



## Expanded Metal Products

**The Expanded Metal Company, Limited**

Burwood House, Caxton Street, S.W.1. WHItchall 1736

STRANTON WORKS, WEST HARTLEPOOL. HARTLEPOOLS 2194

ALSO AT: ABERDEEN, BELFAST, BIRMINGHAM, CAMBRIDGE,  
CARDIFF, EXETER, GLASGOW, LEEDS, MANCHESTER



## VIBRATING EQUIPMENT for QUALITY CONCRETE

**PETROL AND ELECTRIC  
INTERNAL VIBRATORS**

**SALE or HIRE**

Manufacturers of vibrating tables, internal vibrators, external vibrators, petrol and electric vibrating tampers, vibrating screens, pan vibrators, electric motors, petrol engines, builders' hoists and winches, and hydraulic bar croppers.



# E. P. ALLAM & CO. LTD.

LONDON: 45 Great Peter Street, S.W.1. Telephone: Abbey 6353 (5 lines)

SCOTLAND: 39 Cavendish St., Glasgow, C.S. Tel: South 0100. Works: Southend-on-Sea. Tel: Eastwood 55943

# CONCRETE



Anderson's Concreting Paper, a bituminised waterproof product, is ideal for road or floor concreting. It prevents the water from draining away from the underside of the concrete, and thus allows a uniform set throughout the thickness. Supplied in rolls 112 yards in length and 36 inches wide. Samples and particulars sent on request.

**ANDERSON'S CONCRETING PAPER** *and*  
D. ANDERSON & SON LIMITED, STRETFORD, MANCHESTER  
**FLEXPAND**  
EXPANSION JOINTING

Roach Road, Old Ford, London, E.3

THE  
**GUNITE**  
 CONSTRUCTION CO. LTD.

*Specialists in the Repair and Reconditioning  
 of Damaged and Defective Concrete Structures*

**LININGS FOR RESERVOIRS, TUNNELS, ETC.  
 ENCASING STRUCTURAL STEELWORK**

**WESTERN HOUSE, HITCHIN, HERTS. Telephone : HITCHIN 571**



**BOLT** down those new machines and get them working right away with Rawlbolts! Rawlbolts save time—no grouting-in—no waiting for cement to harden. Fix the switchgear—wiring—lighting—fire and canteen fittings and all similar equipment with Rawlplugs. Rawlplugs are the world's firmest and speediest screw fixings in brick, cement, concrete and all solid materials.

*Use Rawlplug Fixing Devices where "speed is the essence of the contract"*

**RAWLPLUG**  
 FIXING DEVICES

WRITE FOR TECHNICAL LITERATURE

**THE RAWLPLUG COMPANY LIMITED • CROMWELL ROAD • LONDON • S.W.7**

B395



# THORNTONS FOR REINFORCED CONCRETE CONSTRUCTION

The long list of contracts of all kinds and sizes carried out by us in reinforced concrete reflects the very wide experience we have had in this class of work. We undertake contracts in any part of the country, and invite Engineers and Architects to include our name on their lists for future enquiries.

*William*

## THORNTON & SONS LTD



38 WELLINGTON ROAD  
LIVERPOOL 8

# prestressed and precast concrete for building and civil engineering



*A symbol of quality materials, experienced workmanship, expert supervision, and excellent service.*

We specialise in the production of prestressed and precast concrete structural members to standard or special designs, including railway sleepers, and shall be pleased to submit quotations for contracts in most parts of the country.

## H. B. CONCRETE CO LTD

Head Office : East Street, Epsom, Surrey.  
Telephone : Epsom 4041/4042.

Branch Works : Vicarage Road, Egham, Surrey.  
Telephone : Egham 3092/3093.

# GUNITE SPECIALISTS

## WM. MULCASTER & CO. (CONTRACTORS) LTD.

We invite inquiries for Gunite Linings and Renderings  
for new or old structures of every kind in any part  
of the country.

**HASLINGTON**

**CREWE**

Telephone : Crewe 2265-6.



## **INSEPARABLE**



### **THUNDER and LIGHTNING**

"Lightning (or thunder) can't be far away", we say, as we hear or see its counterpart rend the heavens.

In dealing with constructive, as well as with destructive, elements we note the same fixed association of ideas. For, whenever Architects and Engineers have in project some great building requiring secure foundations, thoughts turn to Piles—and thence to FRANKIPILES.

To so many concerned with construction problems, Piling always means FRANKIPILING, a single word denoting the cast-in-situ system of Piled Foundations which has been so well tried all over the world for its security, speed of operation and economy.

# **FRANKIPILES**

**carry more tons per pile**

**THE FRANKI COMPRESSED PILE COMPANY LIMITED**

**39 VICTORIA STREET, LONDON, S.W.1**

Telephone : ABBey 6006-9

Telegrams : FRANKIPILE, SOWEST, LONDON

**SOUTH AFRICA : THE FRANKIPILING CO. of S.A. (Pty.) LTD., DURBAN and CAPE TOWN**

# STONE COURT AGGREGATES



*General View of Plant at Rickmansworth.*

## ONE OF OUR MODERN CONCRETE AGGREGATES PLANTS

High-grade concrete aggregates graded to any specification, and the most punctual delivery service in England, can now be given to all Contractors, Builders, and Municipal Authorities carrying out concrete work and road construction in London and Suburbs and the Home Counties.

Washed all-in Ballast 2 in. down.

$\frac{3}{4}$  in. Washed & Crushed or Un-crushed Shingle.

$\frac{1}{2}$  in. Washed & Crushed or Un-crushed Shingle.

Washed Pit Sand.

Soft Sand.



$\frac{3}{8}$  in. Crushed Grit.



**STONE COURT BALLAST CO. LTD.**  
PORTLAND HOUSE, TOTHILL ST., WESTMINSTER, S.W.1

Telephone: Abbey 3456.





**We run our deliveries  
to suit the progress  
of your job**

In the good old days when steel was plentiful we had to sell Isteg on its merits as a bar. These days its merits are taken for granted and the most important thing about Isteg is the service which stands behind it.

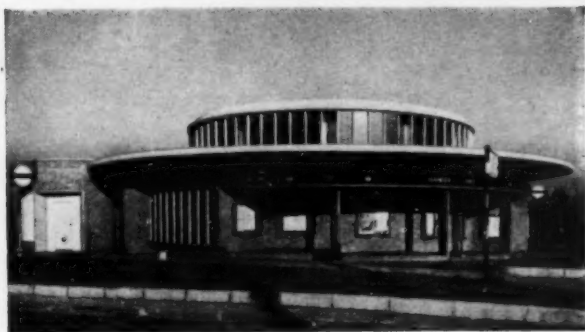
If you design in Isteg you can rely upon it being delivered when and as you need it, carefully bundled and accurately labelled for easy handling on the site. What's more you'll be helping to make more steel available for other urgent needs.

*for*

*Concrete Reinforcement*

**I S T E G**  
  
**S T E E L**

**ISTEG STEEL PRODUCTS LTD. (SALES)**  
43 UPPER GROSVENOR ST. LONDON W.1. Tel.: GROsvenor 1216  
ISTEG is manufactured by Guest Keen & Nettlefolds (Cwmbran) Limited, Cwmbran, McCall & Co. (Sheffield) Ltd., Templeborough, Sheffield. The United Steel Companies Ltd., Sheffield and ISTEG STEEL PRODUCTS LTD.



## • GLASCRETE •

Dr. F. F. Curtis, Chief Architect of L.P.T.B. (Western Region), used effectively Glascrete (reinforced concrete and glass) mullion bar windows in his very striking design for Hanger Lane Station, shown above.



**J.A. KING & Co.  
LTD**

151, Queen Victoria St. LONDON, E.C4

—“ there's no need to  
paint GLASCRETE ”

Telephone : CENTRAL 5866 (6 lines).

# COLOURS *for* ASPHALT

Introducing a new range specially prepared for  
ASPHALT by the Manufacturers of the well-known

**“ SHADEACRETE ” COLOURS FOR CEMENT**

LET US SEND YOU SAMPLES AND PRICES OF

RED • BLUE • YELLOW • GREEN • BROWN

**W. HAWLEY & SON, LTD.**

Colour Works, DUFFIELD, Derby

Phone: Duffield 2294/5

COLOUR MAKERS SINCE 1838

Grams: Hawley, Duffield

*At Home  
and Overseas . . .*

**TAYLOR  
WOODROW**

**CONSTRUCTION LIMITED**

**BUILDING AND  
CIVIL ENGINEERING  
CONTRACTORS**

LONDON, W.1. TELEPHONE: GROSVENOR 8871  
SOUTHALL, MIDDLESEX. TELEPHONE: WAXLOW 2366

Reinforced Concrete Storage Bins for  
Glass and Refractory Sand Grading  
Plant.

## REINFORCED CONCRETE

BRIDGES • RIVER AND SEA DEFENCE  
WORKS • WATER TOWERS • BUNKERS  
SILOS • INDUSTRIAL BUILDINGS • ROADS  
FOUNDATIONS & PILING



# A. G. MANSELL & CO. LTD

CIVIL ENGINEERING AND BUILDING CONTRACTORS

78 BUCKINGHAM GATE, LONDON, S.W.1.

TELEPHONE: WHITEHALL 8735-6-7.

*Is FLOORING your problem?*

*These*

**SEALOCRETE**

*Products*

*will help solve it*



BRITISH RAILWAYS SOUTHERN SECTION, OCEAN TERMINAL DOCK  
SOUTHAMPTON

Designed by J. H. Jellett, Esq., Docks Engineer. Chief Assistant Architect:  
C. B. Dromgoole, Esq.

### SEALOCRETE DOUBLE STRENGTH PREMIX

makes floor toppings dustproof, oilproof, case hardened and permanently waterproof.

### SEALOCRETE CONCRETE SURFACE DRESSING

applied to newly laid or existing concrete floors renders them dustproof, greaseproof, oilproof and case hardened. Sealocrete Coloured Concrete Surface Dressing in 12 colours for use on floors not subjected to heavy traffic.

### SEALANTONE LIQUID COLOURS

for incorporating into cement floors, made in 12 standard shades. Over two million yards of coloured concrete flooring have Sealantone Liquid Colours incorporated.

### SEALOCRETE METALLIC HARDENER

finely graded metallic compound which when incorporated with Granolithic floor toppings gives a very hard surface capable of withstanding extremely heavy usage.

### SEALOCRETE COLOURED CORK FLOORING

COMPOUND produces a light duty floor which is warm, resilient, colourful and waterproof.

## SEALOCRETE PRODUCTS LIMITED

ATLANTIC WORKS  
HYTHE RD., LONDON, N.W.10

Telephone: LADbroke 0015/6/7.  
Telegrams & Cables: Exploiture London





## CEMENTATION

WILL SEAL WATER LEAKAGES THROUGH CONCRETE, ROCK OR SUB-SOILS, AND WILL STABILIZE SUB-STRATA TO ARREST SETTLEMENT OF STRUCTURES ON FAULTY FOUNDATIONS. ALSO BY THIS PROCESS DETERIORATION OF CONCRETE OR OF MASONRY WORKS CAN BE REMEDIED.

## BORED PILES

CAST *in situ* PILES CAN BE PUT DOWN TO GREAT DEPTH WITH A MINIMUM OF HEADROOM AND VERY LITTLE VIBRATION, WITH DESIGNED BEARING CAPACITY.  
OUR WIDE EXPERIENCE IS AT YOUR DISPOSAL.

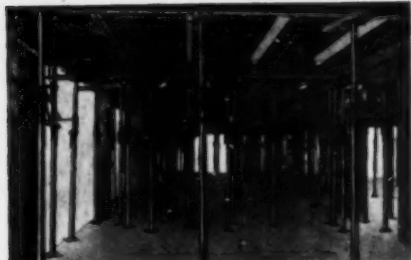
## GUNITE

RECONDITIONING DAMAGED AND DEFECTIVE CONCRETE STRUCTURES.  
ENCASING STRUCTURAL STEELWORK.  
LINING TUNNELS, CULVERTS, RESERVOIRS.  
COVERING THE WEARING SURFACES OF CHUTES AND BUNKERS.

**THE CEMENTATION**  
**C O. LTD.** Telephone Don 54177-8-9 BENTLEY WORKS, DONCASTER.

LONDON OFFICE: 30, VICTORIA STREET, S.W.1  
TELEPHONE: ABBEY 5726-7-8.

# Even where labour



**CONSIDER SOME  
OF THE USES TO WHICH  
ACROW ADJUSTABLE STEEL PROPS  
CAN BE PUT TO SAVE TIME,  
LABOUR AND MATERIALS**

Instead of  $9 \times 9$ 's for shoring heavy formwork :

Raking columns :

Strutting wide trenches :

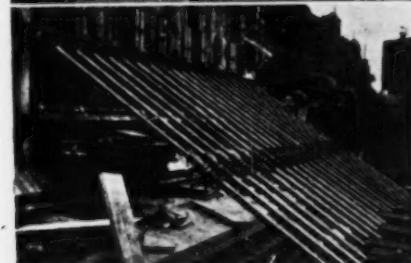
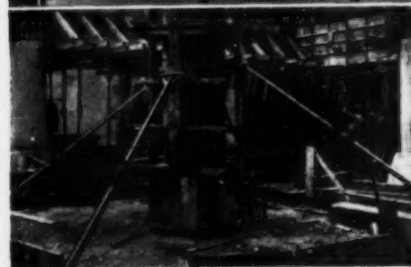
Underpinning temporary structures :

Raising roofs for increased head-room :

Lintel supports :

Jacking formwork :

Staircase shuttering :

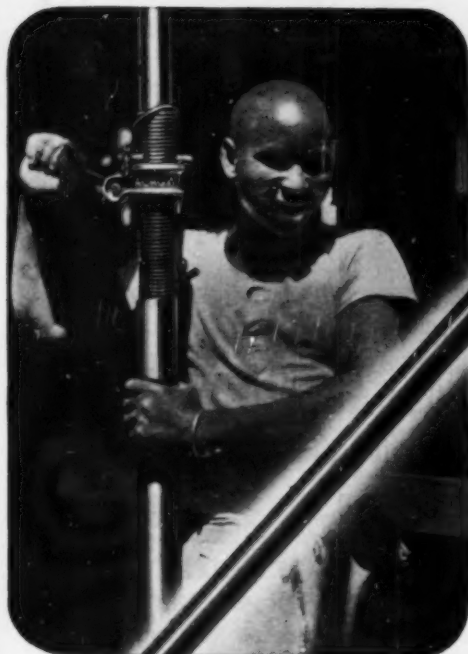


*Remember  
to send  
Acrow Props  
to every site*

## IT STANDS TO REASON IT

**ACROW—the world's largest selling Prop. Over 1,000,000 in use.**

# costs are lowest..



★ Photographed in South Africa

★  
... they  
find it  
profitable  
to use

## ACROW PROPS

★  
Only Acrow Props have the  
patent self-cleaning nut.

# WILL PAY YOU TO USE THEM

All enquiries to—ACROW (ENGINEERS) LTD., South Wharf, Paddington, London, W.2 (Ambassador 3456)  
130 Coventry Drive, Glasgow, E.1 (Bridgeton 1041) ● 22-24 City Road, Bristol, 2 (Bristol 24595)  
West Stanley Street, Manchester, 5 (Trafford 2965) ● Lupton Street, Hunslet, Leeds, 10 (Leeds 76514)



# THE "JOHN BULL" CONCRETE BREAKER

NEW "B.A.L." TYPE.

**INCREASED :—**

PENETRATION, RELIABILITY, LIFE.

**REDUCED :—**

VIBRATION, NOISE AND WEAR.

THESE ARE THE SALIENT FEATURES  
OF THE NEW CONCRETE BREAKER

★ ★ ★

**REAVELL & CO., LTD.**

RANELAGH WORKS, IPSWICH.

TELEGRAMS: "REAVELL, IPSWICH."

TELEPHONE: 2124



WASHED  
**BALLAST, SAND, SHINGLE &**  
Crushed Aggregate for Reinforced Concrete.

**WILLIAM BOYER & SONS, LTD.**

*Sand and Ballast Specialists,*

**IRONGATE WHARF,  
PADDINGTON BASIN, W.**

MEMBERS OF B.S. & A.T.A.

DELIVERED DIRECT TO ANY  
CONTRACT BY MOTOR LORRY.

Quotations on Application.

Telephone: Paddington 2024 (3 lines).



# AQUAREP

SEND FOR  
DETAILS

for 100%  
WATERPROOF  
CONCRETE

**DAMP-PROOFING LTD.**

DEPTFORD Tel. TIDewy 1486-7 LONDON, E.V.



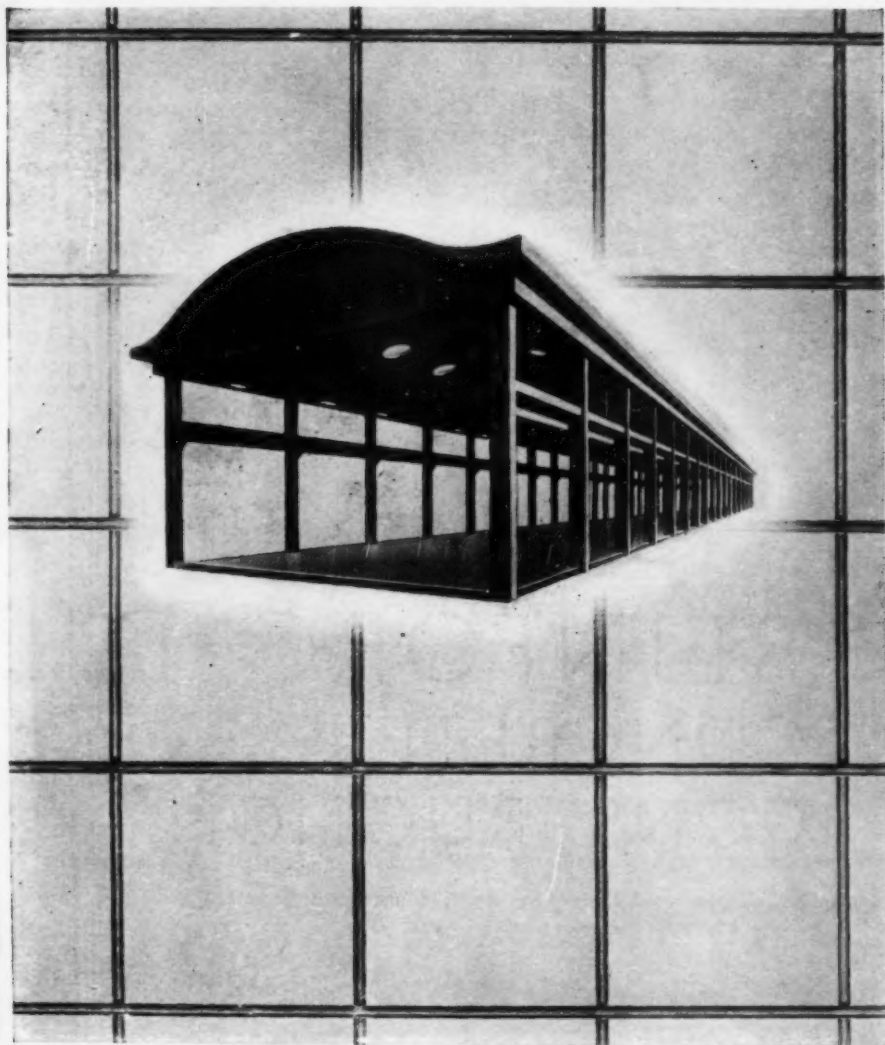
# REINFORCED CONCRETE CONSTRUCTION

CONSULTING ENGINEER,  
Walter C. Andrews, O.B.E.,  
M.I.C.E., M.I.Struct.E.

Elevated Roadway and Beet Silos under construction for  
the British Sugar Corporation, Allscott, Shropshire

**KENT & SUSSEX** CONTRACTORS LTD.  
SIDCUP, KENT  
**RUSH & TOMPKINS** (SA) LTD  
DURBAN, NATAL  
(ASSOCIATED COMPANY)

## **DESIGNS AND REINFORCEMENT**



### **TWISTEEL** REINFORCEMENT LIMITED

LONDON: 43 UPPER GROSVENOR STREET, W.1. Tel: Grosvenor 1216. BIRMINGHAM: ALMA STREET, SMETHWICK 40. Tel: Smethwick 1991. MANCHESTER: 7 OXFORD ROAD, MANCHESTER. Tel: Ardwick 1691. GLASGOW: 146 ARGYLE STREET, C.2. Tel: Central 4551.



# COPPER STRIPS

## for expansion joints

All Reinforced Concrete Engineers recognise the advantages of using copper strips for sealing joints in concrete work. Copper is ductile, will not crack under repeated bending, is non-corrosive and is unaffected by wet concrete. We specialise in the supply of perforated copper strips of all required lengths and widths for expansion joints, and shall be pleased to submit prices against detailed specification.

**ALEX J. CHEETHAM LTD.**

MORTON STREET • FAILSWORTH • MANCHESTER

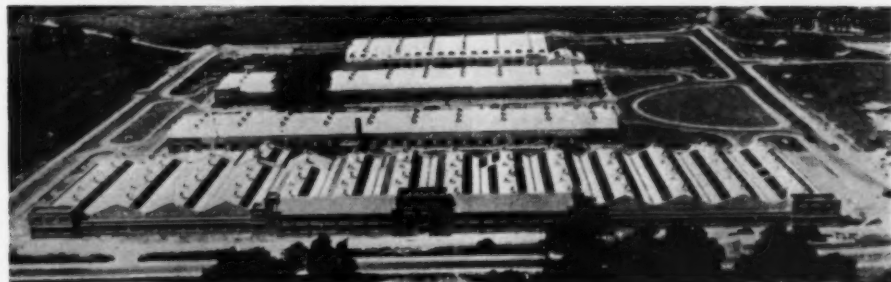
Telephone: FAilsworth 1115/6



DS14

## MELLITOL CEMENT WATERPROOFER

### and PROVER II for new and old FLOORS



**VALE OF LEVEN ESTATES.** Base concrete floors waterproofed with EVODE MELLITOL incorporated in the mix and granolithic finish hardened and dustproofed with EVODE PROVER II Surface Treatment. Consulting Architects: Messrs. Wylie, Shanks and Wylie, Glasgow. Co-ordinating Surveyors: Messrs. James Barr & Sons, Glasgow. Contractors: Messrs. W. & J. R. Watson, Ltd., Edinburgh. Published by courtesy of Scottish Industrial Estates, Ltd.

● "MELLITOL" Cement Waterproofers Waterproofs and Improves Concrete, Cement Renderings, Precast Stone. EVODE "MELLITOL" is specially designed to meet your waterproofing problems. Minimises Cracking and Cracking in bulk concrete. Only 1 lb. "Mellitol" required to 100 lb. of cement—no special mixing. EVODE "MELLITOL" is an established waterproofer by PATENT RIGHTS. Severe tests over a period of years in many countries have established its efficiency. Use "MELLITOL" and cut the cost for waterproofing by half.

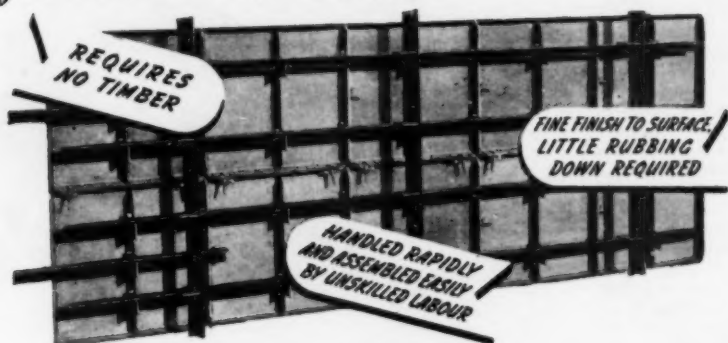
● EVODE PROVER CRYSTALS—the effective hardening treatment for cement surfaces, concrete and granolithic floors. Eliminates dusting and resists the erosive action of oils, acids, etc. EVODE PROVER CRYSTALS have a silica base—scientifically prepared to obtain the maximum chemical reaction on the soft particles of concrete and transforming them into hard flint-like compounds. The result is a permanent, hard-wearing, dustless floor. Does not contain silicate of soda. Send for folder giving details of treatment and price list.

**EVODE Ltd., Glover Street, Stafford**

Tel.: 1590 • 1 • 2.

Grams: EVODE

# "BLAWFORMS"... *The simplest... most economical... most adaptable shuttering for concrete construction.*



The key to  
"Blawform" efficiency  
There are only four simple operations in 'Blawform' assembly:—



Panels are joined by cross keying—the wedge-shape keys ensure positive locking of panels and flanges.



Horizontal liner ties are secured by cross keying to the centre angle of panels.

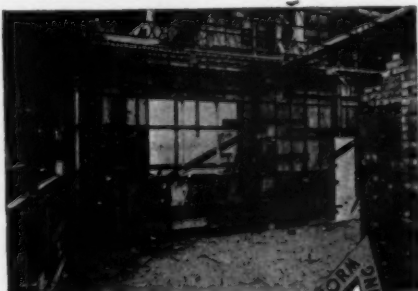


Liner secured in correct position by single key—this brings panels into correct horizontal alignment.



Vertical liner ties and vertical flanges, secured by one key fitting, ensure correct vertical alignment.

BLAW KNOX pioneered the development of steel shuttering for concrete construction and today, after more than 30 years' unrivalled experience, "BLAWFORM" Shuttering gives the lowest handling cost per cubic yard of concrete placed on all types of construction. "BLAWFORM" Shuttering is offered for sale or hire and schemes can be prepared by our specialist staff without placing the contractor under any obligation.



"BLAWFORM" Steel Shuttering in use on mass production of concrete houses.

**BLAW KNOX LIMITED** 90/94 BROMPTON ROAD, LONDON, S.W.3.

Telephone: Kensington 5151

Telegrams: BLAWNOX, SOUTHKENS LONDON

B.K.59a.

# CONCRETE AND CONSTRUCTIONAL ENGINEERING

Volume XLVI. No. 6.

LONDON, JUNE, 1951

## EDITORIAL NOTES

### Labour in the Construction Industry.

THE helpful attitude now being taken by some trade union leaders in the general prosperity of their industry as apart from the welfare of the workers alone, and a realisation on their part that questions relating to the well-being of the workers cannot be separated from the problems of the employers and building owners, is well shown by the report of the meeting of the Building, Civil Engineering, and Public Works Committee of the International Labour Office held at Geneva in February last. Representatives attended from nineteen countries. The United Kingdom delegation comprised a representative from the Ministry of Labour and another from the Ministry of Works, two representatives of the employers, and two representatives of trades unions; it is a sign of the changing times in which we live that the two representatives of labour were gentlemen with titles (Sir Luke Fawcett and Sir Richard Coppock) while the representatives of the Government and of the employers were plain Mist'ers.

The recommendations of the committee show that some trades union leaders at any rate are now taking a wide view of their responsibilities. For example, it is recommended that workers in the construction industry should be ready to take any work which they are reasonably capable of doing, to move to areas where work is available, and to be trained in various skills. This conception of the work that may be done by a member of a trade union is directly contrary to the practice in Great Britain to-day. It means that one man would be able and willing to work at more than one trade, which is at present banned by nearly all trades unions. The recommendation is an excellent one, but it is doubtful if it will be readily agreed to by members of craft unions who jealously refuse to allow a worker in one trade to handle the tools of another. The idea is so revolutionary that it seems hardly possible that it can come about even after many years. With the safeguards necessary to prevent men being familiar with several trades but masters of none, with consequent inferior workmanship, it is a suggestion that would greatly reduce the cost of building by removing restrictions that prevent men from working while they wait for another trade to finish. We see no reason, for example, why a man who has become a competent bricklayer could not learn to lay tiles, to drive a lorry, or to attend to a concrete mixer, or why a carpenter employed on shuttering could not be a competent steel fixer, a good musician or a sports champion. The trend towards specialisation must not be allowed to belittle natural ability and aptitudes; otherwise we class men as machines capable of doing one thing only.

It might also be suggested that a number of the men now classed as labourers be taught a trade. This would also prevent delays, for it is common nowadays for work to be stopped for lack of tradesmen although many labourers are available. It seems that insufficient attention has been paid to the results of the increasing use of mechanical devices on building and civil engineering works. Machinery has done little to reduce the number of craftsmen required on a construction site. It has, however, made large numbers of unskilled labourers redundant, with the result that there is often a surplus of labourers who have no work because no tradesmen are available. It is worth seeing whether some of these labourers who have had experience on construction sites could be trained as craftsmen, for the present trend in the use of machinery in construction is to replace labourers rather than tradesmen. This will increasingly alter our old conceptions of the number of tradesmen compared with labourers required on a construction site, for while one man and a machine may do the work of fifty navvies working with hand tools, the fullest use of machine tools at present available for carpenters, electricians, and others may not save one man in five.

The report contains many suggestions for improving output at a time when it seems that in all parts of the world construction work is being delayed because of the scarcity of materials and of building trades workers. Throughout the report the importance of full employment is emphasised, not only in the building industry but in other industries, and it is realised that the greater the employment in a country as a whole the more work there will be for the construction industry. As is all too common, however, no definition is given of what is meant by full employment. These words should mean a state where everyone is busily and usefully at work. In practice, however, it generally means a state where everyone receives a wage whether or not the work he does is useful or, indeed, whether or not he is doing a full day's work. We do not have to go far to see one man watching another working, with no excuse that the work is so arduous that half the day is needed for rest. This is not full employment. Lack of clear thinking on this subject is shown by a statement in the report that full employment has helped to reduce seasonal unemployment, whereas obviously there can be no seasonal unemployment in a state of full employment.

There are suggestions for improving working conditions such as the provision of shelter when work is interrupted by bad weather, facilities for obtaining food under decent conditions, for washing, for drying clothes, and so on. Much has been achieved in this direction during the past few years, and perhaps it is only their novelty that has caused these amenities to be abused in some cases. But such amenities are among the fundamental rights of human beings. There can be no return to the days when "hands" were wanted and "hands" were discarded, when the hands only were important and the human beings who owned them were left to shift for themselves in matters such as shelter, and sanitary, washing, and clothes-drying arrangements. Such improvements in working conditions are stages in the improvement in living conditions that has been going on, with some setbacks, throughout history. Claims that these amenities cannot be afforded now are no sounder than the arguments of last century which predicted the ruin of the nation if children under twelve years of age were prevented by law from working less than twelve hours a day in a factory or mine. Insofar as higher standards of living increase production the world will be a better place for all.

## A Concrete-Lined Tunnel in Scotland.

### NOVEL FEATURES ON THE LOCH FANNICH HYDRO-ELECTRIC WORKS.

THE Loch Fannich works is the first stage in the development for hydro-electrical purposes of the basin of the river Conon, Ross-shire, by the North of Scotland Hydro-Electric Board. Water from Loch Fannich flows through the tunnel described in this article to a generating station at Grudie Bridge. The head of water available for the two 12,000-kw. turbines is 530 ft., and will be increased by 20 ft. when a dam is constructed at the loch. The scheme differs from common hydro-electric practice since, instead of placing the intake to the tunnel at the side of the loch and raising the level of the water by a dam, the tunnel is driven

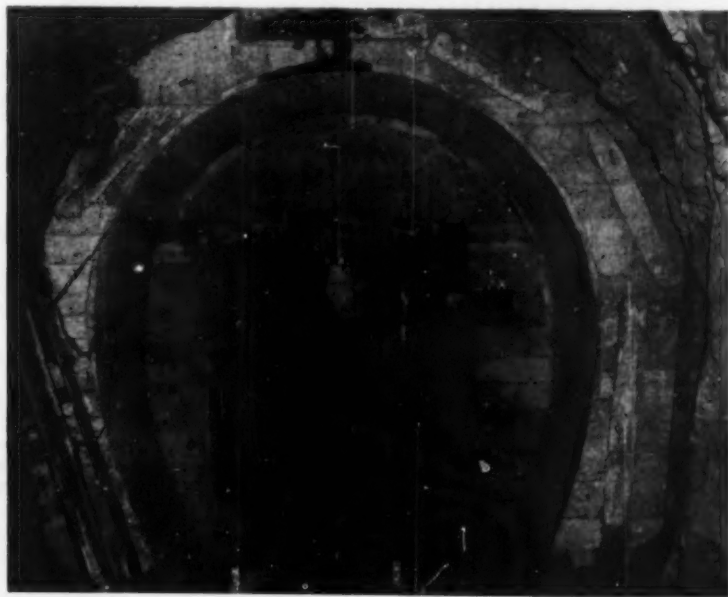
under the loch and a connection made about 80 ft. below water level. This method enables much more of the capacity of the loch to be used as a seasonal storage reservoir. The driving and lining of the tunnel and shafts are described in this article by permission of the Board.

The following notes and illustrations on the construction were contributed by Mr. K. McInnes of Messrs. Balfour, Beatty & Co., Ltd., the contractors for the civil engineering works. Technical data and drawings were supplied by the consulting engineers, Sir Alexander Gibb & Partners.

### I.—THE TUNNEL.

The length of the tunnel (*Fig. 2*) between Loch Fannich and the portal above the generating station is 19,484 ft. From an adit driven into the hillside at right-angles to the tunnel, the tunnel was driven 4300 ft. to the portal in one

direction and 9600 ft. in the opposite direction to meet the heading 4900 ft. long driven from the bottom of the screen-shaft. From the gate-shaft the tunnel was driven under the loch and eventually connected to the loch. The



**Fig. 1.—Temporary Concrete Bulkhead No. 1.**



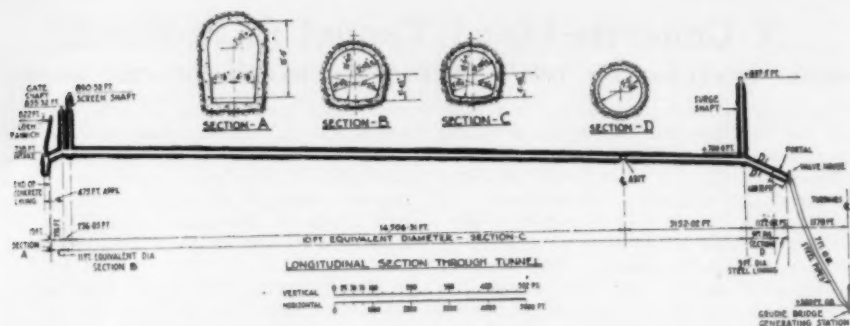


Fig. 2.—Longitudinal and Transverse Sections of Tunnel.

surge-shaft is 3200 ft. from the adit. The tunnel and shafts are lined with concrete. The length of 470 ft. from the gate-shaft to the loch includes 336 ft. of horse-shoe cross section of 11-ft. equivalent diameter ("Section B"); the minimum thickness of the concrete lining is 20 in., and it is strengthened with 8-in. by 5-in. steel arch-ribs at 5 ft. centres as a precaution against shock when the connection to the loch was made. The length of 17,890 ft. from the gate-shaft to the surge-shaft is of horse-shoe cross section of 10-ft. equivalent diameter ("Section C"), and the minimum thickness of concrete over points of rock in the walls is 5 in. and 4 in. in the invert. The length of 1124 ft. from the surge-shaft to the portal is circular, 9 ft.

diameter ("Section D"), and is lined with concrete except for a length of 400 ft. from the portal which is lined with a steel pipe backed with concrete. Work commenced on the tunnel in March, 1947, and occupied about  $3\frac{1}{2}$  years. The average number of workmen was 350, the greatest number being 700.

#### Excavation.

The tunnel is generally in hard quartzite (Moine schist), although mica schist was encountered at one part, and no supports were necessary. The total quantity of rock excavated was about 90,000 cu. yd. The long tunnel of 10 ft. equivalent diameter was driven by drilling from jumbos and blasting. The spoil was removed by rocker-shovels loading

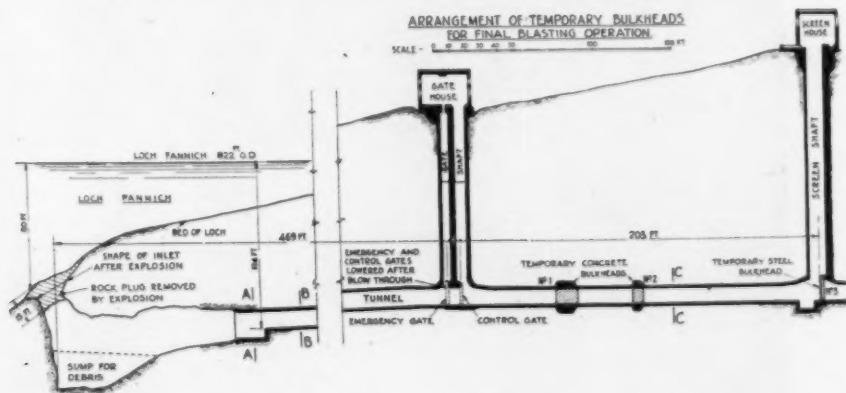


Fig. 3.—Temporary Bulkheads.



2-cu. yd. skips hauled in trains by electric locomotives on 2-ft. gauge track. The speed of driving the tunnel varied considerably with the hardness of the rock, but generally a complete round of drilling, blasting, and removal of spoil took one shift of 8 hours. The greatest advance on one face was nearly 150 ft. in a week with fifteen men in each shift working three shifts a day, or twenty shifts in a week.

Excavation of the 9-ft. diameter circular tunnel was more difficult because of

of 10 ft. of tunnel forming the throat was excavated upwards towards the loch, thus reducing the cover to 15 ft. As the sump is 18 ft. wide and 48 ft. deep, it was flooded to within a few feet of the roof of the tunnel, and drilling in the roof of the tunnel was done from a pontoon. Pilot holes to ascertain the thickness of the rock were made ahead of the excavation and were later sealed with beechwood plugs and grouted. When only 15 ft. of cover remained, 102 holes terminating about 2 ft. from the bed of the



**Fig. 4.—Travelling Shuttering for Walls of 10-ft. Tunnel.**

the gradient of about 1 in 23 and the smaller working space. Drifters on column bars were used. The locomotives could not haul more than two loaded skips at a time up the incline.

In the 11-ft. equivalent diameter tunnel, driving was by the heading-and-bench method, using drifters on column bars, to the point where a sump was formed in the floor of the tunnel to contain about twice the estimated amount of rock to be blasted in the break-through to the loch. Beyond this point a small top heading was driven to within 25 ft. of the bed of the loch. The sumps were then excavated, the spoil being removed by a scraper-loader, and a further length

loch were drilled, and 96 of these were loaded with about 1 ton of explosive and all detonated at the same time. The rock at the intake is a quartz-mica schist (granulite) and the amount blasted by the explosion was about 270 tons. To reduce the effect of an inrush of water, the tunnel from the gate-shaft towards the loch was filled with water until the water in the shaft was about 12 ft. below the level of the water in the loch. The back pressure of this water also helped the shattered rock to fall into the sump. To ensure that the water would not rush through the tunnel, temporary bulkheads were constructed (*Fig. 3*). Instruments at the foot of the gate-shaft recorded the

force of the explosion, which it was estimated would be about 120 tons per square foot. Bulkhead No. 1, nearest the loch, was a concrete plug 12 ft. 6 in. thick. Bulkhead No. 2 was 36 ft. from the first bulkhead and was a concrete plug 6 ft. 6 in. thick. If the shock pressure of nearly 10,000 tons on bulkhead No. 1 caused this bulkhead to fracture, then bulkhead No. 2 would have to resist only the pressure of the water without the

was again available down the gate-shaft. This is only the second time that this method of connecting a tunnel to a lake has been used in this country. After the explosion, the two permanent steel gates were lowered to the bottom of the gate-shaft so that the water between the gate-shaft and bulkhead No. 1 could be removed and the concrete bulkheads demolished. The removal of the bulkheads took a week. Vertical and hori-



Fig. 5.—Travelling Shuttering for Roof of 10-ft. Tunnel.

shock of the explosion. Bulkhead No. 3 was a temporary gate of steel joists at the bottom of the screen-shaft, and was an additional precaution. Bulkhead No. 1, however, resisted satisfactorily the full force of the explosion. While the gate-shaft was temporarily closed for lining, it was necessary to leave openings in the concrete bulkheads for the passage of skips of spoil from the incomplete tunnel under the loch. The openings were closed during blasting operations by 12-in. gates of timber baulks (Fig. 1), and were filled with concrete when access

zontal cuts were made by a machine, and the remainder of the concrete was demolished by the plug-and-feather method.

The gate-shaft and screen-shaft were sunk from the surface, drilling being done by jack-hammers and sinkers and the spoil being loaded by hand into crane buckets. The surge-shaft was excavated partly upwards from the tunnel. A small vertical shaft, or stope, was driven from the tunnel to the surface, and was then enlarged to the full size by excavating from the surface, the spoil being thrown

down the stope, at the bottom of which was a steel hopper outlet through which the rock was discharged into skips in the tunnel.

#### Concrete and Concrete Plant.

There are about 45,000 cu. yd. of concrete in the lining and elsewhere in the tunnel and shafts. The cement was brought in 1-cwt. paper bags by boat to Invergordon and thence by road to the site, where it was stored in cement sheds at the adit and intake. Sand was

in the lining of the tunnel of 10-ft. equivalent diameter is  $5/1\frac{1}{2}$ . The maximum size of the aggregate in concrete placed by pump is  $\frac{3}{4}$  in., the concrete in the gate-shaft, screen-shaft, and lining the tunnel of 11-ft. equivalent diameter being  $6/8$ . Tests were made regularly of the materials, and slump tests and cubes were made of nearly every placing of concrete. Most of the concrete was weigh-batched at plants at the adit and intake.

The batching plant at the adit had



Fig. 6.—Timber Shutter for Upper Part of Walls of 11-ft. Tunnel.

delivered by road from a pit at Beauly. Much of the rock from the tunnel was suitable for aggregate, and a crushing, washing, and screening plant was installed at the adit to produce aggregates, conforming to British Standard No. 882, in three sizes, namely  $1\frac{1}{2}$  in. to  $\frac{3}{4}$  in.,  $\frac{3}{4}$  in. to  $\frac{1}{2}$  in., and  $\frac{1}{2}$  in. to  $\frac{3}{8}$  in., which were mixed to give the required grading.

The mixture of the concrete was designated by the number of hundred-weights of cement to be mixed with 12 cu. ft. of sand and 20 cu. yd. of aggregate (or slight variations of these quantities) and the maximum size of the aggregate. For example, concrete containing 3 cwt. of cement and  $1\frac{1}{2}$ -in. aggregate was called  $3/1\frac{1}{2}$ . The concrete

four compartments which were filled with aggregate from the stockpiles by a derrick grab-crane. The weigh-hopper was of the beam-balance type with four sets of levers and weights, and discharged into the chute-hopper of a 1-cu. yd. mixer. The bags of cement for a batch of concrete were broken into a skip which was on rails running the length of the cement shed and out to the batcher. The skip was emptied into the hopper of a hoist, which discharged the cement into the chute-hopper of the mixer. The concrete was discharged from the mixers into skips on tracks in front of the mixer and conveyed into the adit.

The batching plant at the intake also comprised four compartments, and was

fed by skips on tracks over the bins. The weigh-batcher was of the turntable type and could feed into the hopper of either of two  $2\frac{1}{4}$  mixers. Bags of cement were slid down a chute from the cement shed and broken into the hoppers. The mixers discharged into skips which were hauled by a winch up a ramp to

(Fig. 4) comprised the carriage, which allowed traffic to pass through the centre of the tunnel, and steel shutters mounted on both sides of the carriage. Jacks at the top and bottom enabled the shutters to be moved in or out for striking or resetting. The length of the shutter was generally 70 ft., but one length of 100 ft.



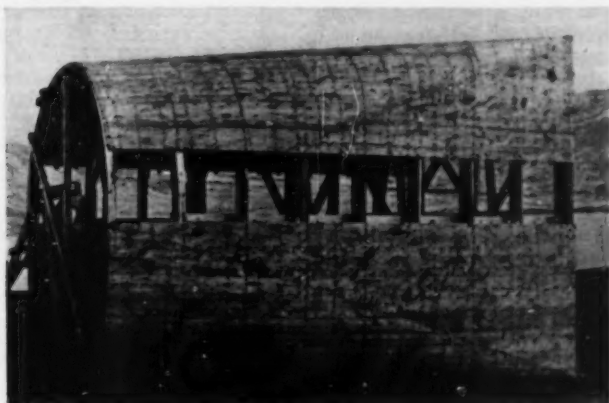
Fig. 7.—Lining of 11-ft. Tunnel complete except for Invert.

lifts in the screen-shaft by which they were taken down into the tunnel.

#### Lining the Tunnels.

The lining of the tunnel of 10-ft. equivalent diameter was done in four stages. The haunches were concreted first, and rails were spiked to wooden plugs driven into holes drilled in the haunches. The rails carried the steel carriage of the travelling shutters for the walls and roof. The shutter for the walls

was also used. The plates had ports about halfway up and at 5 ft. centres horizontally. The concrete was brought into the tunnel in  $\frac{1}{2}$ -cu. yd. trays mounted on bogies, and was shovelled through the ports until the level of the concrete reached the bottom of the ports, which were then closed and the concrete shovelled over the top of the shutter. Steel shutters supported on props with screw-jacks (Fig. 5) were used for the roof. For moving the shutters, another

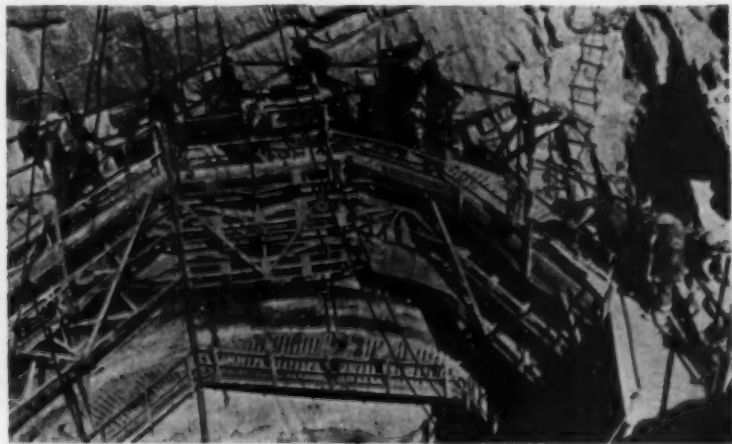


**Fig. 8.—Transition Shutter at Gate-shaft : From 11-ft. by 10-ft. Rectangle to 10-ft. Horseshoe Cross Section.**

carriage was run under the shutter which was then lowered on to it. The shutter had doors covering the crown of the arched roof. Concrete was also brought in on  $\frac{1}{4}$ -cu. yd. trays, which were also used as platforms, and one team of men commenced at one end of the shutter and filled up to the level of the door. Another team followed, closing the doors in turn and filling over the top of each. Since only two men could do the last operation, the roof-shutters were only 20 ft. and 40 ft. in length, but there were more roof

shutters than wall shutters. For concreting the invert, steel beams were placed at 6 ft. centres across the tunnel to support the track clear of the invert, which was then trimmed and concreted. A shaped screed sliding on concrete nibs formed on the walls was used.

In the steel-lined part of the 9-ft. diameter circular tunnel, a concrete invert was laid to carry the track, on which 16-ft. sections of the steel lining were rolled into place. The sections were then welded together, and generally



**Fig. 9.—Inner View of Continuously-moving Shutter for Surge-Shaft.**

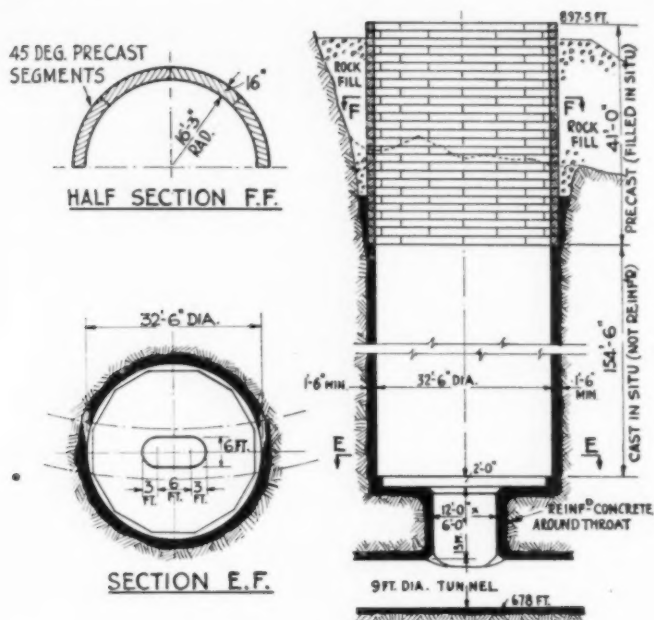


Fig. 10.—Surge-Shaft.

a 16-ft. length was concreted at a time. A 4-in. concrete pump and a 14/10 mixer were installed in a sump in the tunnel. Batches of aggregate were brought in from the adit batching plant and stored with the cement on a platform behind the mixer. The pipes from the pump were run over the steel lining. To allow access to assemble the pipes and ram the concrete, extra excavation was taken out of the roof.

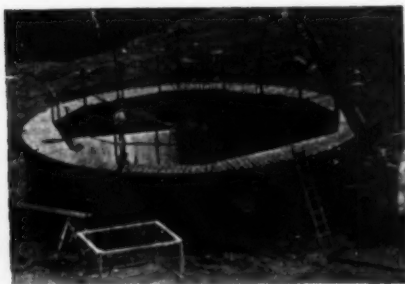


Fig. 11.—Outer View of Continuously-moving Shutter for Surge-Shaft.

The first stage of lining the concrete part of the circular tunnel was to concrete the invert by means of the concrete pump. The timber shutter, which was used for the sides and roof was in halves, the joint being at the centre of the crown. Upon removal of a key-piece, the halves could be pulled together for striking, and the shutter was then rolled forward on small timber rollers and wedged apart for resetting. The concrete was placed behind the shutter by the concrete pump.

Access to line the tunnel of 11-ft. equivalent diameter was generally only possible down the gate-shaft, one well of which was occupied by the skip for removing spoil and the other well by ladders, pipes, and the temporary gate. Therefore a 4-in. concrete pump and a 21/14 mixer were installed at the top of the shaft. Batches of cement and aggregate were mixed dry in one of the batching-plant mixers and carried by belt-conveyors to the hopper of the mixer at the shaft. Concrete was pumped down the 125-ft. shaft successfully without choking by providing a vent at the top of the vertical pipe and an easy bend at the



bottom. A timber shutter 80 ft. long was provided (Fig. 6), a length of 40 ft. being filled at a time. The concrete was brought up to about 1 ft. over the crown of the arch, and after 24 hours was filled to the rock. This method avoided undue weight being imposed on the shutter since the concrete, which is reinforced by steel ribs as seen in Fig. 6, is several feet thick where an excessive amount of rock has been excavated. Fig. 7 is a view in this part of the tunnel before the invert was concreted. Closure lengths of the lining near the bottom of the screen-shaft were also concreted by pump, and at one time the pumping distance was about 260 ft. horizontally from the pump at the gate-shaft to the top of the screen-shaft, 160 ft. down the screen-shaft, and 360 ft. along the tunnel. Difficulties experi-

enced at first were overcome by creating a vacuum in the vertical pipe by exhausting air from the top vent. A small section of this tunnel was lined with concrete shot into place.

The special shuttering required for the bends, transitions, and connections with the shafts was of timber, although one easy bend in the 10-ft. tunnel was shuttered by a 20-ft. length of the straight steel shutters. The shutters for transition sections were generally made by attaching narrow boards to shaped centres, and were erected completely above ground, cut into sections, and taken down into the tunnel. The transition shutter in Fig. 8 is for a part of the tunnel where the cross section changes from a rectangle 11 ft. by 10 ft. to a 10-ft. horseshoe section.

## II.—THE SHAFTS.

The surge-shaft (Fig. 10) is 32 ft. 6 in. diameter and about 200 ft. deep, and has a throat 6 ft. wide, 12 ft. long, and 13 ft. deep connecting to the tunnel. It was intended to use a steel shutter in which concrete could be placed to a depth of 6 ft. at a time, but, to accelerate the work, this shutter was strengthened, and converted to a continuously-moving form (Figs. 9 and 11). Fourteen jack-rods (Figs. 12 and 13).



Fig. 12.—Jack for Continuously-moving Shutter for Surge-Shaft.

June, 1951.



Fig. 13.—Jack Rods in Surge-Shaft.

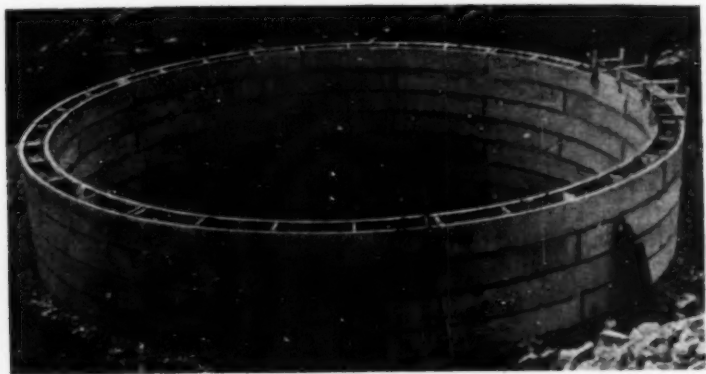


Fig. 14.—Precast Segmental Wall at Top of Surge-Shaft.

13) were fixed to the sides of the shaft. The concrete was mixed at the adit batching plant and brought through the tunnel in skips, which were hoisted through the throat to the shutter by a 10-tons derrick crane at the top of the shaft. After movement of the shutter had started, a smaller crane was installed on the ledge around the throat to lift the skips through the throat, the derrick crane then lifting them from the ledge to the shutter, thereby saving time. A depth of about 3 ft. of concrete was kept in the shutter,

and it moved upwards about 6 in. per hour. The upper part of the surge-shaft (Fig. 14) is constructed of hollow precast concrete segments in courses each 18 in. deep. There are eight 45-deg. segments in each ring, and after they had been bedded in 1 : 2 mortar they were filled with  $5\frac{1}{4}$  concrete reinforced with ring bars set in slots in the tops of the webs.

The gate-shaft is 125 ft. deep and the timber shutters for the two wells (Fig. 15) were each 5 ft. 6 in. deep; enough

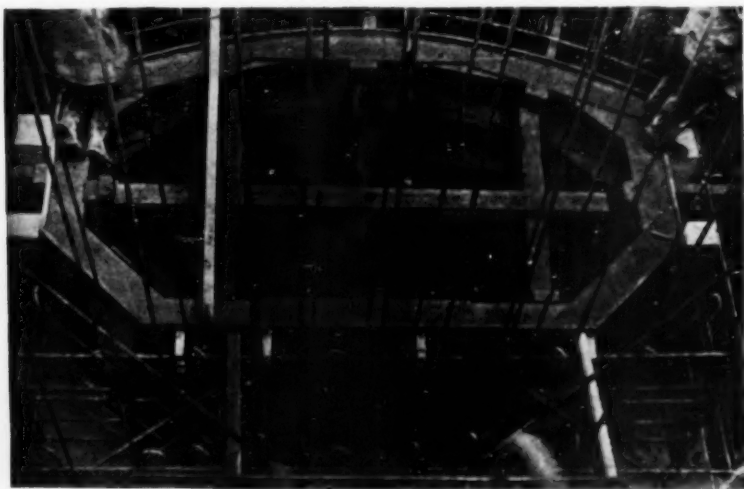


Fig. 15.—Shutter for One Well of Gate-Shaft.

shutters were made to concrete one-third of each well. The materials were measured in batch boxes and mixed in a 21/14 mixer at the top of the shaft which discharged into a skip handled by a derrick crane. The average time taken to set the shutter, fix the reinforcement, and concrete a lift was about 36 hours, but varied considerably according to the distance down the shaft at which concrete was being placed.

The screen-shaft is 160 ft. deep and lifts were installed in it for taking men and materials down to the tunnel; while the shaft was being lined the lifts were removed, and a 10-in. pipe with a hopper

at the upper end and a sector-gate at the lower end were installed in the shaft for passing concrete into the tunnel. Later it was possible to finish lining the main tunnel from the adit. Timber shutters each 5 ft. 6 in. deep were used for the screen-shaft, sufficient shutters being made to line nearly half the shaft. As lining the 11-ft. tunnel was finished by this time, the pipe from the concrete pump at the gate-shaft was laid to the top of the screen-shaft and down to the shutter. It was possible to fix the reinforcement well ahead of the lining, and a shutter could be set and concreted in 24 hours.

### Pressure of Concrete on Shuttering.

THE probable pressures on vertical shuttering in *Table I* are based on data derived from tests and given by M. Guerrin in a recent number of "La Technique de Travaux". It is seen that even if the extreme cases of liquid and earth-damp concretes are ignored, the pressures vary by 75 per cent. to 150 per cent. depend-

crease from 25 per cent. to 40 per cent. if the temperature rises from 60 deg. to 100 deg. F. The "silo" effect in narrow shuttering may result in a decrease up to 30 per cent. of the pressure of ordinary concrete, and a decrease up to 10 per cent. with vibrated concrete. The "silo" effect does not occur with liquid concrete,

TABLE I.—MAXIMUM PRESSURE (lb. per square foot) OF WET CONCRETE ON SHUTTERING.

Rate of placing (cu. ft. per hour)	Mass of indefinite width		Columns (about 18 in. square)		Walls (about 5 in. thick)	
	10	35	10	35	10	35
Consistency:						
"Earth damp" . . . . .	332	415	167	215	84	87
Suitable for vibration . . . . .	485	523	504	528	457	463
Ordinary . . . . .	733	922	582	704	659	659
Liquid . . . . .	1230	1530	1230	1530	1230	1530

ing upon the consistency. If the rate of placing is increased from about  $\frac{1}{4}$  cu. yd. per hour to about  $1\frac{1}{4}$  cu. yd. per hour, the pressures increase up to 25 per cent. and this is especially so if the concrete is in wide walls or beams. If the concrete is in thin walls or beams or is vibrated, the rate of placing appears to be of little importance. An increase in temperature causes a decrease in pressure; for example, the pressure may de-

but in the case of "earth damp" concrete it may reduce the pressure by a half. Tests in the U.S.A. have shown that with liquid concrete the pressure may be about 50 per cent. greater for a rich mixture than for a lean mixture. The influence of the nature of the shuttering is negligible, although for ordinary concrete the pressure on steel shuttering may be about 3 per cent. greater than on wooden shuttering.

## Book Reviews.

**"Reinforced Concrete Designer's Handbook."** By C. E. Reynolds. Fourth Edition (revised). (London: Concrete Publications Ltd. 1951. Price 18s.)

In this edition the opportunity has been taken to include additional tables and notes giving the requirements of the British Standard Code, CP.114 (1948), for working stresses, bond, slabs spanning in two directions, the moment of resistance of beams and slabs, and the safe loads on columns. The requirements of the D.S.I.R. Code, the London By-laws (1938), and the code of the Institution of Civil Engineers for Liquid-containing Structures are retained. New tables and examples give an improved method of calculating the bending moments on rectangular slabs subjected to triangularly-distributed pressure, and the loads on groups of vertical and inclined piles in wharves and jetties. Other new matter includes a calculation chart for fixed-end symmetrical arches, the general formulæ for the longitudinal forces in prismatic slab structures, and formulæ for I-beams. There are 75 tables and about 265 pages of explanatory text, formulæ, diagrams, examples, and specifications.

**"Modern Bridge Construction."** By F. Johnstone Taylor. Second Edition. (London: The Technical Press, Ltd. 1951. Price 30s.)

This book of about 300 pages deals mainly with steel bridges. The design of reinforced concrete bridges of beam, fixed-arch, and rigid-frame types is dealt with in 18 pages, and their construction in 39 pages. The formulæ and design data are not sufficiently explained to be of

great value, and some statements are misleading; for example, that the tensile resistance of the concrete is sometimes considered in the design of arches. Also, Waterloo bridge is not an arch structure, although the girder may appear to be arches because the soffit is curved. In some places the book has not been brought up-to-date, since Berwick bridge can hardly be described as "recently completed", and the Traneberg bridge of 563-ft. span is not the longest reinforced concrete arch, as the Sandö bridge, completed in 1943, has a span of 866 ft.

**"Der Stahlbeton in Beispielen. No. 2. Durchlaufende Platten."** By Adolf Kleinogel. (Berlin: Wilhelm Ernst & Sohn. 1951. Price 9 D.M.)

In this second of a series of small books the author deals with the calculation of continuous slabs in six numerical examples illustrating different arrangements of spans and combinations of loading, slabs spanning in two directions, and the application of influence lines to rolling loads. The examples are taken from actual work, and are fully worked out. The main purpose of these booklets is to provide students with ready answers to points not covered in an incomplete technical education.

## Publications Received.

**"Sources of Road Aggregate in Great Britain."** Second Edition. (London: H.M. Stationery Office, 1951. Price 3s.)

**"Symposium on Use of Pozzolanic Materials in Mortars and Concretes."** 208 pages. (Philadelphia: American Society for Testing Materials. 1950. Price 2.50 dollars.)

## International Association for Bridge and Structural Engineering.

PAPERS printed in the tenth volume of the Publications of the International Association for Bridge and Structural Engineering include the following. A report of the test of the 160-ft. prestressed concrete girder for the Walnut Lane bridge, Philadelphia, by M. Fornerod; A theory and method of design of the girders of a bridge with several longitudinal girders, taking into account the torsional resistance of the girders, by C. Massonett; The measurement of the stresses in a bent reinforced concrete

beam with special reference to the bond of the bars, by L. P. Brice; An analysis of continuous beams on elastic foundations and deformed by shearing forces only, by A. Holmberg; A simplified method of analysing Vierendeel girders, by F. Stüssi; The best manner in which the material in a structure can be used, by R. Vallette; Test of a plastic model of a curved reinforced concrete viaduct, by G. Wästlund and L. Östlund. The Publications (no price stated) are obtainable from Verlag Leemann, Zurich.

## Beams with Variable Moment of Inertia.—I.

By B. ERIKSEN, A.M.I.Struct.E.

IN the following is described briefly a method of calculating, by means of fixed points, the bending moments (and thence the shearing forces) in continuous or other restrained beams in which the moment of inertia varies throughout the span. This is an adaptation of the formulæ and other data for beams with constant moment of inertia given by the writer in this journal for January, February, and March, 1948.

The principal symbols are given in *Fig. 1* (symmetrical beams) and *Fig. 3* (unsymmetrical beams).

### Symmetrical Beams.

It is assumed that the moment of inertia varies according to

$$n_x = 1 - (1 - n)\phi^{2r} \quad (1)$$

in which  $\phi = \frac{2x}{l}$  and  $2r$  are indices depending on the shape. The different shapes of the soffit of beams with three values of  $2r$  are shown in *Fig. 2*. If the cross section of the beam is rectangular,

$$d_x = \frac{d_c}{\sqrt[3]{1 - (1 - n)\phi^{2r}}} \quad (2)$$

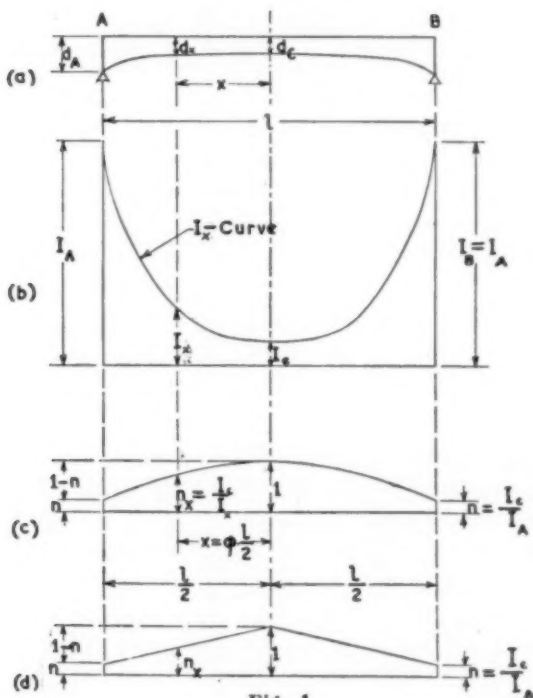


Fig. 1.

TABLE NO. I.

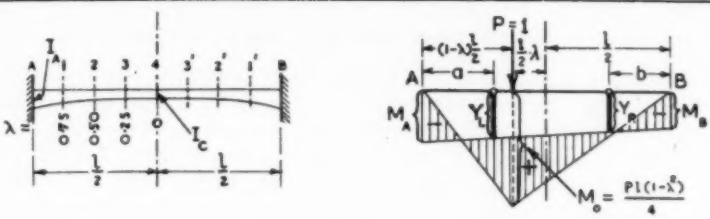


Diagram illustrating the beam configuration and load position. The beam is supported at points A and B, with a central support C. The load P=1 is applied at a distance  $a$  from support A and  $b$  from support B. The total length of the beam is  $l$ . The diagram shows the load position and the resulting bending moment distribution.

2r	$n = \frac{I_C}{I_A}$	Values of $-\frac{Y_1}{a}$ for P=1 Load positions.				Values of $-\frac{Y_n}{b}$ for P=1 Load positions.			
		1	2	3	4	1	2	3	4
1	1.0	0.2051	0.3281	0.3809	0.3750	0.1230	0.2344	0.3223	0.3750
	0.4	0.1877	0.3175	0.3843	0.3871	0.1238	0.2389	0.3328	0.3871
	0.3	0.1838	0.3152	0.3850	0.3898	0.1240	0.2399	0.3348	0.3898
	0.2	0.1794	0.3125	0.3859	0.3928	0.1242	0.2411	0.3373	0.3928
	0.15	0.1771	0.3111	0.3863	0.3945	0.1243	0.2417	0.3387	0.3945
	0.1	0.1746	0.3096	0.3868	0.3962	0.1244	0.2423	0.3402	0.3962
	0.05	0.1719	0.3079	0.3873	0.3981	0.1245	0.2430	0.3417	0.3981
2	1.0	0.2051	0.3281	0.3809	0.3750	0.1230	0.2344	0.3223	0.3750
	0.4	0.1908	0.3209	0.3840	0.3835	0.1238	0.2384	0.3301	0.3835
	0.3	0.1880	0.3195	0.3846	0.3852	0.1239	0.2391	0.3317	0.3852
	0.2	0.1851	0.3181	0.3852	0.3869	0.1241	0.2399	0.3333	0.3869
	0.15	0.1835	0.3173	0.3856	0.3878	0.1242	0.2404	0.3341	0.3878
	0.1	0.1821	0.3166	0.3859	0.3887	0.1243	0.2408	0.3349	0.3887
	0.05	0.1805	0.3158	0.3862	0.3897	0.1244	0.2412	0.3358	0.3897
3	1.0	0.2051	0.3281	0.3809	0.3750	0.1230	0.2344	0.3223	0.3750
	0.4	0.1939	0.3233	0.3834	0.3811	0.1237	0.2376	0.3281	0.3811
	0.3	0.1918	0.3224	0.3840	0.3822	0.1239	0.2383	0.3292	0.3822
	0.2	0.1897	0.3215	0.3843	0.3833	0.1240	0.2389	0.3303	0.3833
	0.15	0.1887	0.3211	0.3846	0.3839	0.1241	0.2392	0.3309	0.3839
	0.1	0.1876	0.3206	0.3848	0.3845	0.1241	0.2395	0.3315	0.3845
	0.05	0.1865	0.3201	0.3851	0.3851	0.1242	0.2398	0.3321	0.3851
4	1.0	0.2051	0.3281	0.3809	0.3750	0.1230	0.2344	0.3223	0.3750
	0.4	0.1962	0.3248	0.3829	0.3795	0.1237	0.2371	0.3268	0.3795
	0.3	0.1947	0.3242	0.3832	0.3803	0.1238	0.2376	0.3276	0.3803
	0.2	0.1931	0.3236	0.3836	0.3811	0.1239	0.2380	0.3284	0.3811
	0.15	0.1922	0.3233	0.3838	0.3816	0.1240	0.2383	0.3288	0.3816
	0.1	0.1914	0.3229	0.3840	0.3820	0.1240	0.2385	0.3292	0.3820
	0.05	0.1906	0.3227	0.3842	0.3824	0.1241	0.2388	0.3296	0.3824



If unit moment is applied at one end of the beam the slope at that end is given by

$$\alpha = \frac{l}{3EI_c} \left[ 1 - \frac{3(1-n)(r+1)}{(2r+1)(2r+3)} \right] \quad (3)$$

The slope at the other end to that at which the moment is applied is given by

$$\beta = \frac{l}{6EI_c} \left[ 1 - \frac{3(1-n)}{(2r+1)(2r+3)} \right] \quad (4)$$

When the slopes  $\alpha$  and  $\beta$  are known, the positions  $a$  and  $b$  of the fixed points can be determined. In the application of the fixed-point method, the ordinates  $Y_L$  and  $Y_R$  to the closing line of the bending-moment diagram at the left-hand and right-hand fixed points are required. In Table No. 1 are given coefficients of  $-\frac{Y_L}{a}$  and  $-\frac{Y_R}{b}$  for unit load acting at any one of four positions on one half of a symmetrical span, and for values of  $2r$  equal to 1, 2, 3, and 4, and for most common values of  $n$ . The coefficients, which are calculated by a complex formula based on a rigid analysis of the slopes, enable the bending moments at, and the influence lines for, each of the positions to be readily calculated.

Influence lines derived from the coefficients enable the effect of most types of loads to be determined, but for a uniformly-distributed load it can be shown by direct analysis that  $Y_L = -\frac{awl}{4}$  and  $Y_R = -\frac{bwl}{4}$ .

An example of the design of a structure with symmetrical beams having variable moment of inertia will be given in the second part of this article.

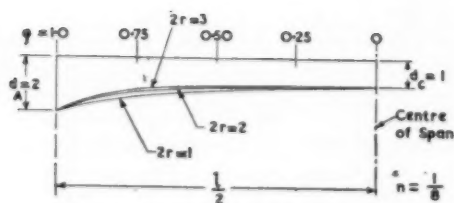


Fig. 2.

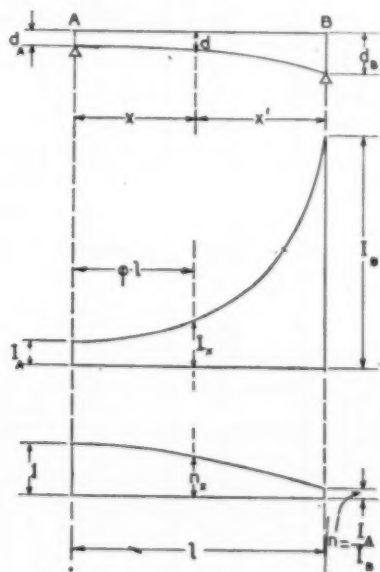


Fig. 3.

TABLE NO. 2.

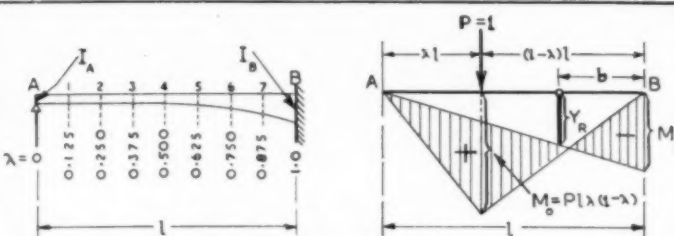


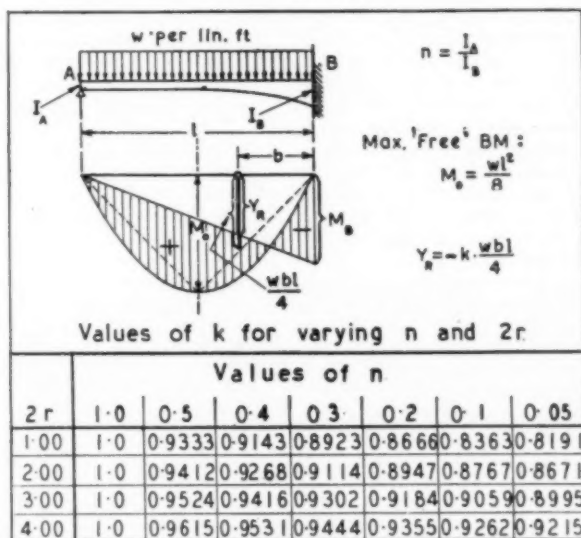
Diagram illustrating the beam configuration and load position. The beam has two spans, with the left span length  $l$  and the right span length  $b$ . A unit load  $P=1$  is applied at a distance  $\lambda l$  from the left support. The beam has moments of inertia  $I_A$  and  $I_B$  at the supports. The diagram shows the load position and the resulting bending moment distribution.

2r	$n = \frac{I_A}{I_B}$	Values of $-\frac{Y_a}{b}$ for $P=1$						
		Load positions.						
		1	2	3	4	5	6	7
1	1.0	0.1230	0.2344	0.3223	0.3750	0.3809	0.3281	0.2051
	0.5	0.1225	0.2305	0.3113	0.3542	0.3504	0.2930	0.1772
	0.4	0.1223	0.2293	0.3082	0.3482	0.3417	0.2829	0.1692
	0.3	0.1221	0.2280	0.3045	0.3414	0.3315	0.2713	0.1600
	0.2	0.1220	0.2266	0.3003	0.3333	0.3198	0.2578	0.1493
	0.1	0.1217	0.2248	0.2942	0.3239	0.3059	0.2418	0.1366
	0.05	0.1215	0.2238	0.2924	0.3185	0.2980	0.2360	0.1293
2	1.0	0.1230	0.2344	0.3223	0.3750	0.3809	0.3281	0.2051
	0.5	0.1227	0.2318	0.3143	0.3585	0.3548	0.2956	0.1774
	0.4	0.1226	0.2312	0.3123	0.3544	0.3482	0.2876	0.1706
	0.3	0.1225	0.2305	0.3102	0.3501	0.3413	0.2790	0.1634
	0.2	0.1224	0.2301	0.3079	0.3454	0.3339	0.2699	0.1555
	0.1	0.1223	0.2290	0.3055	0.3403	0.3259	0.2599	0.1470
	0.05	0.1223	0.2285	0.3042	0.3376	0.3216	0.2546	0.1425
3	1.0	0.1230	0.2344	0.3223	0.3750	0.3809	0.3281	0.2051
	0.5	0.1228	0.2328	0.3167	0.3628	0.3604	0.3010	0.1800
	0.4	0.1228	0.2323	0.3155	0.3600	0.3557	0.2949	0.1752
	0.3	0.1227	0.2319	0.3141	0.3572	0.3508	0.2884	0.1691
	0.2	0.1227	0.2314	0.3128	0.3542	0.3458	0.2817	0.1630
	0.1	0.1226	0.2310	0.3113	0.3510	0.3404	0.2746	0.1566
	0.05	0.1226	0.2308	0.3106	0.3493	0.3376	0.2709	0.1532
4	1.0	0.1230	0.2344	0.3223	0.3750	0.3809	0.3281	0.2051
	0.5	0.1229	0.2332	0.3183	0.3660	0.3650	0.3059	0.1838
	0.4	0.1229	0.2329	0.3174	0.3640	0.3615	0.3011	0.1791
	0.3	0.1228	0.2326	0.3165	0.3620	0.3578	0.2961	0.1743
	0.2	0.1228	0.2324	0.3156	0.3598	0.3542	0.2909	0.1693
	0.1	0.1228	0.2321	0.3146	0.3577	0.3503	0.2856	0.1642
	0.05	0.1227	0.2319	0.3141	0.3566	0.3484	0.2830	0.1616

### Unsymmetrical Beams.

When one end of a beam or other member is freely supported it is often more economical if the depth (or width) increases from a minimum at the free end to a maximum at the support over which the beam is continuous. This shape is fairly common for columns of framed structures as well as for end spans

TABLE NO. 3.



of girder bridges. The adaptation to this case of the data for the symmetrical beams is useful. Fig. 3 shows a beam of this shape, and on the same diagram are given the curves of  $I_x$  and  $n_x$ . With the symbols in the diagram the slope at B due to unit bending moment applied at B is given by

$$\alpha_B = \frac{l}{3EI_A} \left[ 1 - \frac{3(1-n)}{2r+3} \right] \quad (5)$$

The slope at A due to unit bending moment at B is given by

$$\beta = \frac{l}{6EI_A} \left[ 1 - \frac{6(1-n)}{(2r+2)(2r+3)} \right] \quad (6)$$

The coefficients of  $-\frac{Y_L}{a}$ , when calculated on a similar basis to that for symmetrical beams, are given in Table No. 2 for unit load acting at any one of eight positions on the beam, and enable bending-moment diagrams and influence lines to be drawn as before.

Table No. 3 applies to a uniformly-distributed load on an unsymmetrical beam. The ordinates at the fixed points in this case can be expressed as  $k$  times the ordinate for a symmetrical beam, that is,  $Y_R = -\frac{wbl}{4}k$ . Values of  $k$  are given in Table No. 3.

(To be concluded.)

## Continuously-Reinforced Concrete Roads.

At the last annual meeting of the United States Highway Research Board, reports on three continuously-reinforced concrete roads were given, the following details of which are from "Engineering News-Record".

A test road one mile long laid in California in the summer of 1949 has an 8-in. slab in two 12-ft. strips. Half the length is reinforced with  $\frac{1}{2}$ -in. low-strength bars at 4 in. centres, and the other half with high-strength bars at 5 in. centres. The bars are continuous through the construction joints, and amount to 0.62 per cent. and 0.50 per cent. respectively of the cross-sectional area. Attached to the bars are 184 strain gauges and 72 temperature compensation gauges. Only about 5 per cent. of the strain gauges were effective at the end of 18 months. The average stress in bars across cracks after seven months was about 50,000 lb. per square inch in low-strength bars and 81,000 lb. per square inch in high-strength bars. In both cases the maximum stress was reached in less than twelve months. At the end of the first year the average number of cracks in 100 ft. of road was generally 22. There were fewer cracks in the older concrete on one side of each construction joint and more in the first section laid each day. As the reinforcement is continuous, it is probable that the greater cracking is due to the fact that the newer concrete has less strength to resist the shrinkage pull across the joint.

A road laid in Illinois in 1947-48 is  $5\frac{1}{2}$  miles long and is divided into eight sections from 3500 ft. to 4200 ft. in length separated by expansion joints originally 4 in. wide. In four of the sections the slab is 7 in. thick, and 8 in. in the others. The amount of reinforcement is from 0.3 per cent. to 0.5 per cent., and from 0.7 per cent. to 1 per cent. Strain gauges were effective for the first year only. The maximum stress observed across a construction joint was 63,400 lb. per square inch, which is much less than the yield-point stress of the bars. The stress away from the joints did not exceed 10,000 lb. per square inch, indicating that the concrete was resisting a large

part of the tensile forces. The spacing of the cracks is related to the amount of reinforcement, and the width of the cracks is least in the sections with 1 per cent. of reinforcement and widest in the sections with 0.3 per cent. The cracks are more frequent in the zones 300 ft. to 500 ft. from the ends. Most cracks are too narrow to be easily seen. Although it is too early to draw definite conclusions, it is thought that a continuously-reinforced concrete road will give excellent performance, but that it may be necessary to provide more reinforcement than earlier studies indicated.

Two test roads were laid in New Jersey in the autumn of 1947, one 5430 ft. long and 8 in. thick containing 0.9 per cent. of reinforcement, and the other 5130 ft. long, 10 in. thick, and with 0.72 per cent. of reinforcement. Both roads have two independent 12-ft. strips. The reinforcement is double cold-drawn welded wire fabric in which the longitudinal wires are  $\frac{3}{8}$  in. diameter at 3 in. centres. The 8-in. slabs are laid on 12 in. to 14 in. of material of good quality and the 10-in. slabs on 12 in. of the same material. The soil is highly susceptible to pumping. Very heavy vehicles are common on this road. Cracking, except at the ends, is very extensive and erratic, and is greater in the 8-in. slab and more numerous in the outer strips which are subjected to the greatest traffic. Spacing of the cracks is from 6 in. to 20 ft., although it seldom exceeds 12 ft. There is some spalling at the cracks, and where they are close together there is a tendency to form separate small pieces of concrete which shatter and become dislodged. Serious cracks occurred in the newer concrete at construction joints; this suggests the advisability of tying together slabs of different ages, especially if there is a delay of several days between casting the two slabs. The cracks are much wider than they should be if long service is required, and there is raveling at the cracks which, if it continues, will be serious. The 8-in. slab with the larger percentage of reinforcement appears to be in better condition than the 10-in. slab.

## A Canal Cover and Culvert at Cardiff.

A NEW dual-carriageway road, called Churchill Way, Cardiff, was opened in 1949 and is constructed in part over a non-navigational canal conveying water to the docks. The length of the covered canal is about 1700 ft., and the initial design was for a reinforced concrete twin box-culvert. Because of the scarcity of timber and steel and the difficulty of maintaining the flow of water during construction, the design adopted is a single rectangular culvert comprising walls of plain concrete 20 ft. apart and a covering of precast reinforced concrete beams (Fig. 1). When possible the water level in the canal was lowered to enable work to be done, but it was not practicable to

provide a cast-in-situ concrete beam-and-slab cover because for the most of the length there is insufficient distance between the ordinary level of the water and the underside of the cover to allow the use of shuttering. The cover was designed to carry the Ministry of Transport loading for trolley-bus routes.

The cofferdams within which the walls were constructed consisted of steel sheet-piles driven along the centre-line of the canal for a length of about 20 ft., the ends of the piling returning to one bank. Excavation and concreting of this length of one wall and regrading of part of the bed of the canal were done in the dry, after which the ends of the cofferdam



Fig. 1.—Canal Cover at Cardiff.

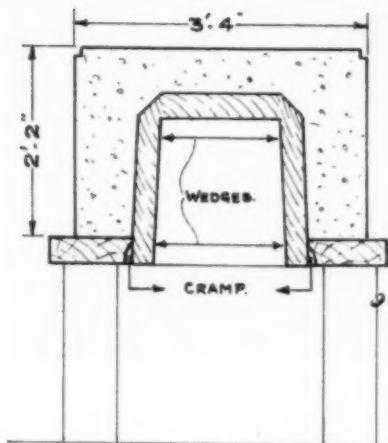


Fig. 2.—Cores for Casting Beams.

were changed to the other bank and the corresponding length of wall opposite constructed.

The beams are of inverted-channel section (Fig. 2), 24 ft. long, 3 ft. 4 in. wide, and 2 ft. 2 in. deep. The vertical ribs are 8 in. wide and the top slab is 6 in. thick. The ends are solid for a length of 2 ft. to provide bearing surfaces on the walls, and the ribs are stiffened at two points by 6-in. diaphragms. The moulds were designed so that the cores could be extracted before the beams were fully matured so that the cores could be used to cast 21 beams each week. The wooden cores were lined with sheet metal to prevent the timber swelling during concreting, and a comparatively large "draw" was provided. The moulds were erected on elevated platforms so that after 24 hours the cores could be extracted from below without disturbing the main

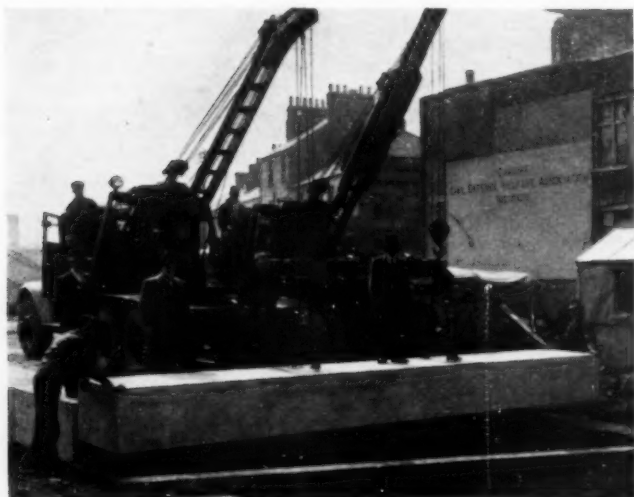


Fig. 3.—Placing Beams in Position.



Fig. 4.—Top Slab of Cast-in-Situ Culvert.





Fig. 5.—Closure Beams.

runners on which the beams rested. The beams remained in position for ten days before being lifted. Rapid-hardening Portland cement was used. The method of extracting the cores was to expand them initially by wedges. After casting, the wedges were removed and a cramp (Fig. 2) applied to the outer lower edges. The runners were notched at intervals to provide a space for the ends of the cramps, which drew the sides of the cores away from the concrete. The reinforcement was assembled before being placed in the mould. The concrete was compacted by two electrically-operated vibrators attached to opposite sides of the moulds.

The beams were placed in position by two mobile cranes (Fig. 3). The beams weigh  $7\frac{1}{2}$  tons each, and were brought from the casting works on special lorries immediately before erection to avoid double handling and stacking at the site.

Two pairs of lifting-links were embedded at the two third-points. The lorry was taken under the two cranes, which lifted the beam, travelled forward, and placed the beam on to the walls on the tops of which cement grout had been placed. As erection proceeded, the cranes travelled over the beams already laid.

It was also necessary to construct an inverted syphon, which is a twin reinforced concrete box-culvert each compartment of which is 10 ft. by 4 ft. Steel sheet-piles were driven in mid-stream to enable the first part of the culvert to be completed and the water was diverted into this while the second part was constructed. The shuttering of the inner faces of the walls of the culvert was ordinary steel panels, but steel sheets, originally the tops of table-shelters, were used for the soffit of the top slab (Fig. 4). Each part of the culvert was constructed in three sections, respectively 61 ft. 6 in., 51 ft., and 28 ft. 6 in. long. The middle section is level and lower than the outer sections and the soffit is 21 in. below the original water level. The foundation was covered with rough concrete to receive the reinforced concrete bottom slab, which was cast monolithically with the splays at the bottom of the walls, where keyed longitudinal construction joints were formed (Fig. 6). The walls were shuttered and cast up to the underside of the upper splays, where similar construction joints were formed. The final operation was the shuttering and casting of the top slab and splays. The space between the end of the cast-in-situ culvert and the precast beams was closed by a special beam (Fig. 5) consisting of two separate

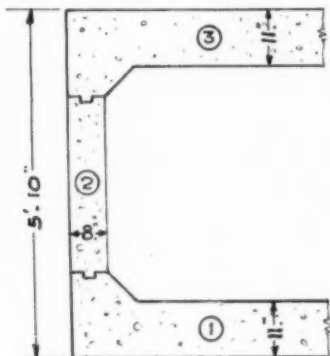


Fig. 6.—Construction Joints.

ribs, cast in the same moulds as the ordinary beams but without a top slab. The ribs were placed in position on either side of the gap, which was about 2 in. out of parallel owing to creep in laying the beams due to a slight warping of the moulds. Rebates on the inner faces of the ribs provided a support for asbestos-cement sheets, which were cut to the slight taper required and formed shuttering for a cast-in-situ slab.

The foregoing notes and illustrations are from a paper by the City Surveyor, Mr. E. C. Roberts, M.Eng., M.Inst.C.E., under whose supervision the works were designed and constructed, published in the Journal of the Institution of Municipal Engineers. The main contractors were Messrs. Maberly Parker, Ltd. The beams were made by the British Fram Construction Co. (1911), Ltd., and were placed by Messrs. Robert Wynn & Son, Ltd.

## Test of a Prestressed Concrete Railway Bridge.

AN under-line prestressed concrete railway bridge (*Fig. 1*) at the Normanby Park Steelworks of Messrs. John Lysaght, Ltd., was recently tested by a locomotive drawing a wagon loaded with steel billets. The structure is a skew bridge, 14 ft. 4 in. wide between the parapets, the angle between the face of the abutments and the longitudinal centre-line of the bridge being 27 deg. 50 min., and the clear span measured at right-angles to the abutments 20 ft. The deck comprises fourteen prestressed precast concrete beams (*Fig. 2*), the length of each of which, because of the skew, is 48 ft. Concrete was cast in situ between and over the beams. The bearing of the beams on the abutments

is 2 ft. measured at right-angles to the face of the abutments. The beams are tied together by  $\frac{3}{4}$ -in. twisted square bars passing transversely across the bridge at 2-ft. centres through holes in the webs of the beams. The thickness of the concrete over the beams is 6 in. at mid-span tapering to 3 $\frac{1}{2}$  in. at the abutments. The slope of the top of the slab, which is covered with asphalt, facilitates drainage.

The beams are an inverted tee in cross section, 27 in. deep and 8 in. wide; the width of the flange is 13 $\frac{1}{2}$  in. At the bottom, there are sixty-four 0.2-in. diameter wires having a tensile strength of 100 tons per square inch; there are six-

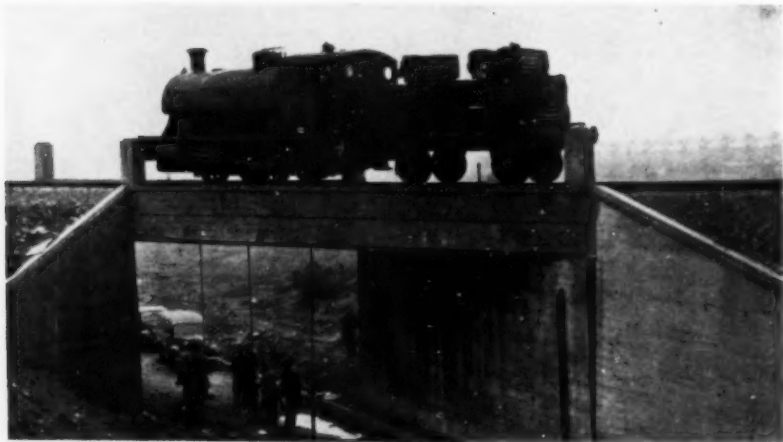


Fig. 1.



**Fig. 2.**

teen wires at the top. It is assumed that the precast and cast-in-situ parts of the bridge act together as a monolithic structural member. A description of a test on one of the beams, which confirmed this assumption, was given in this journal for August, 1950.

The weights of the test load were about 37 tons from the locomotive, 32.2 tons from the front axle of the wagon, and 30.2 tons from the rear axle. The train travelled over the bridge three times with

the wagon leading, and the deflection was measured under each parapet and at the centre. The maximum deflections were 0.019 in. under the parapet and 0.02 in. at the centre. The ratio of deflection to the span was about  $\frac{1}{27,000}$  for the skew-span, or about  $\frac{1}{12,000}$  for the right-span.

The bridge was designed by Twisteel Reinforcement, Ltd., and the beams were made by Costain Concrete Co., Ltd. The bridge was built by the Demolition & Construction Co., Ltd.

### **Conditions of Contract.**

THE third edition of "General Conditions of Contract" for civil engineering works was published in March, 1951, by the Institution of Civil Engineers, the Association of Consulting Engineers, and the Federation of Civil Engineering Contractors. The revisions made to the previous edition (January, 1950) include the following. Disputed claims by the contractor are submitted to an arbitrator at the option of the contractor, and in connection with the settlement of disputes the Arbitration Act of 1950 is quoted. Slight alterations have been made to the

definition of "excepted risks" and to the provisions to apply upon outbreak of war. The contractor has the exclusive use of plant and material, which when brought on the site by him become the employer's property. A new clause regarding the reinstatement of highways is included. A certificate of completion of parts of a works used by the employer will be awarded upon application by the contractor provided that, unless stated to the contrary, the certificate is not deemed to apply to ground or surfaces needing reinstatement.

## A Pipe Bridge in Italy.

The design and construction of an unusual pressure-main bridge across the river Velino, Italy, is described by G. Turazza in "Beton- und Stahlbetonbau" for October, 1950. The pipe is in the form of an arch of 197 ft. span (Figs. 1 and 2) having a radius of 175 ft. and a rise of 30 ft. The internal radius of the circular pipe is 3.28 ft.; the thickness is 10 in. at the crown of the arch increasing to 20 in. at the springings, where the curved pipe joins the horizontal main.

The design of the arch took into account

radial sector at  $O_1$  (Fig. 3) at an angle  $\phi$ . The  $y$ -ordinate of  $O_1$  is  $R(1 - \cos \phi)$ , and the hydrostatic pressure  $p_{01}$  at  $O_1$  is  $w(y + h)$ , where  $w$  is the weight per unit volume of water. The pressure  $p$  at point B on the perimeter of the pipe is  $p_{01} - w(B'O_1) \cos \phi$ , and since  $B'O_1$  is  $r \cos \psi$  (see the cross section in Fig. 3),  $p = w[h + R(1 - \cos \phi) - r \cos \psi \cos \phi]$ .

The corresponding pressure parallel to the vertical diametrical axis of the pipe is  $p \cos \psi$  per unit length of pipe and



Fig. 1.

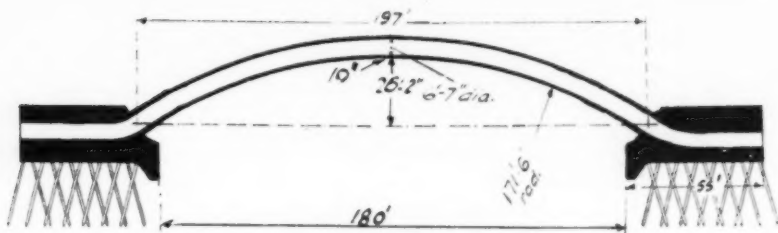


Fig. 2.

the weight of the pipe and the water, the internal water pressure, shrinking of the concrete, and change of temperature. The stresses due to dead weight were calculated in the ordinary way. In considering the effect of the water in the pipe it was considered that in filling the pipe the water would rise gradually in one half until it flowed over the invert at the crown and, when completely filled, the hydrostatic pressure might be due to a head of not less than the diameter of the pipe or to a maximum head of 57.5 ft. In the case of the pipe being full, the resultant of the hydrostatic pressure was computed by considering a

acts on an area  $da$  of  $\frac{R + (B'O_1)}{R} r \cdot d\psi$ ,

that is  $da = \frac{r}{R}(R + r \cos \psi) d\psi$ .

Therefore the resultant of all forces acting on unit length of pipe is given by

$$q = 2 \int_0^\pi p \cos \psi da \\ = \pi w r^2 \left( \frac{h}{R} + 1 - 2 \cos \phi \right)$$

Substituting  $\pi w r^2 = W$  and  $\frac{h}{R} + 1 = k$ ,

$$q = W(k - 2 \cos \phi).$$

*Warning!*

# STEEL FORMS

**The multiple system of Steel Shuttering for  
in-situ concrete construction**

Stocks are getting lower  
—the time will come  
when we shall have to say  
—sorry cannot deliver  
until . . .

**Don't wait—place your order now.**

**A. A. BYRD & CO., LIMITED**

**210, Terminal House, Grosvenor Gardens, London, S.W.1.**

'Phone: SLOane 5236.

'Grams: Byrdicom, Wesphone, London.

# VIBRO PILES

## at Carrington Power Station

At this site more than 3,000 Vibro piles were driven, the pile lengths ranging from 26 to 50 ft. All pile tops were finished to the required level, a matter of no difficulty with Vibro cast-in-place piles.

Consulting Engineers : C. S. Allott & Son (Manchester).

General Civil Engineering Contractors : A. Monk & Co. Ltd.

Sub-contractors for Vibro piling : John Gill Contractors Ltd.

*Photograph by courtesy of  
British Electricity Authority.*



**BRITISH STEEL PILING CO. LTD.**

Kings House, 10 Haymarket, S.W.1. Tel. : Trafalgar 1024/8 Grams. : Pilingdom, Lesquare, London



The force  $q$  acts radially and is positive when  $k$  exceeds  $2 \cos \phi$ . Since at the crown  $\cos \phi = 1$ ,  $q$  is always positive if  $h$  exceeds  $R$ . When  $h$  is less than  $R$ ,  $q$  is negative at some sections near the crown. In this structure, and generally for low-pressure mains,  $q$  is always negative and acts as a variable radial force. In high-pressure mains  $q$  may be great enough to reverse the shearing force at the crown and produce a tensile force.

In the design of the arch, the resultant of the forces  $q \cdot ds$  (Fig. 3) between the crown and any section  $O_1$  was calculated, and its components  $X$  and  $Y$  and moment  $M$  about the centre of any section determined. Considering a segmental element (angle  $d\alpha$ ), the force  $q \cdot ds$  is  $qR \cdot d\alpha$ ; the

ance with ordinary methods, which gave the following maximum values.

	At Crown.	At Springings.
Thrust (lb.)	- 560,000	- 478,000
Bending moment (ft.-lb.)	+ 2,605,000	- 7,000,000
Compressive stress in concrete (lb. per square inch)	1,081	880
Tensile stress in reinforcement (lb. per square inch)	16,200	15,100

The maximum stresses at the crown are produced by the dead weight, the pipe full of water ( $h = 3.28$  ft.), and a fall of temperature of 25 deg. C., and at the springings by the dead weight, half the pipe full, and a fall of temperature of 25 deg. C. The maximum tensile stress in the concrete, which occurs when  $h$  is 57.5 ft., is due to a tensile force of

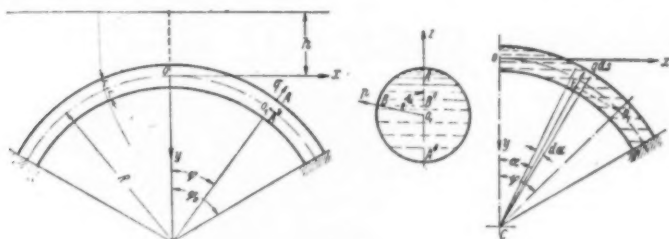


Fig. 3.

component  $dx$  is  $Rq \sin \alpha \cdot d\alpha$  and  $dy$  is  $- Rq \cos \alpha \cdot d\alpha$ . Hence

$$X = \int_0^\phi dx = RW[k(1 - \cos \phi) - \sin^2 \phi].$$

$$Y = \int_0^\phi dy = RW(\phi + \sin \phi \cos \phi - k \sin \phi).$$

The moment  $dM$  of  $q \cdot ds$  about  $O_1$  is  $qR \cdot d\alpha(O_1F)$ ; therefore

$$M = \int_0^\phi dM = R^2W[k(1 - \cos \phi) - \phi \sin \phi],$$

which is positive for rotation clockwise.

Values of  $X$ ,  $Y$ , and  $M$  at ten equidistant sections were calculated from these formulæ with  $h = 3.28$  ft. ( $k = 1.019$ ). The analysis of the forces in a partly-filled pipe is more complex than for a full pipe. (The derivation of formulæ for and values of  $q$  for the pipe with the water at the level of the invert at the crown are given in the original article.) The calculation of the arch was made in accord-

51,900 lb. and, with an assumed modular ratio of 40, is 93 lb. per square inch in a pipe 10 in. thick. The maximum compressive stress in the longitudinal direction of the pipe (with  $m = 10$ ) is 853 lb. per square inch, and the maximum compressive stress radially is 17 lb. per square inch. Assuming Poisson's ratio to be 0.125, the principal stress is 202 lb. per square inch. As the pipe had to be watertight it was necessary to avoid cracking, and the two abutments were designed to prevent unequal settlement. Each abutment is supported on 68 piles inclined at 15 deg. from the vertical.

The centering for the arch comprised a cradle carried on three trusses supported on sand boxes on the abutments and on two intermediate temporary piers. The sections against the abutments were concreted completely, the invert of the pipe was then concreted in nine sections working from three intermediate points, and concrete was placed later in the four spaces between the five principal sections.

**Patent Relating to Concrete.  
Concrete Improver.**

CONCRETE is hardened by applying agents which react with one another to fill the pores, the different agents being mixed separately into an aqueous emulsion of soap and an oil, and the emulsion broken by means of an acid to produce a viscous and oleaginous paste. The material is prepared by dissolving soap (preferably soft soap) in water, stirring in a heavy oil such as colza oil, and then introducing separately ground lime or marble, potassium silicate, and calcium chloride. After thorough mixing and, if necessary, the addition of more water, approximately 3 per cent. by weight of the cement of concentrated hydrochloric acid is added, preferably in the gauging water. If the setting-time is reduced too much, potassium chromate may be included—No. 606,153. H. Avellan. January 7, 1946. [Note. Publication of specifications by the Patent Office has been delayed by the war.]



**WATERPROOFING  
RAPID SETTING & HARDENING  
DUST · OIL & ACID PROOFING**

Send for full details of the complete range of PALLAS PRODUCTS. Free technical advice is available on all waterproofing problems.

**PALLAS CHEMICALS LTD.**  
53 WELLBURN PARK, NEWCASTLE-ON-TYNE

★ **Special Jaws**

**for cutting**



**high - tensile steel wire  
for Prestressed Concrete**

★ The well-known RECORD BOLT CLIPPER can now be supplied with SPECIAL TEMPER JAWS which will cut high-tensile steel wire easily and quickly, will last longer, and are more economical than any other type of clipper for prestressed concrete work. For full details enquire through your Tool Dealer or the Manufacturers.

**C. & J. HAMPTON LTD.** RECORD TOOL WORKS  
SHEFFIELD, 2

The full range of RECORD TOOLS includes Planes, Vices, Cramps, Bolt Clippers, Pipe Tools, etc.

# 'RITECURE'

## membrane curing

### for concrete runways roads · floors · walls and precast products



"Ritecure" membrane curing material forms a cellophane-like skin on the surface of the concrete. Since it is applied before the setting of the cement has taken place, it ensures retention of the maximum amount of moisture in the concrete, eliminating hair and wind cracking caused by too rapid drying out of the cement in the face of the concrete immediately after laying. It is not affected by the heat of the sun and, while it is not sold as an anti-frost mixture, since "Ritecure" itself will not freeze, it gives protection against 5-10° of frost.

This one-man operation of curing concrete—horizontal or vertical surfaces—has brought concrete curing to a simple, speedy and economical process, whereby the highest degree of curing efficiency is obtained without the use of costly covering materials and their heavy handling charges. It is easily applied through a spray, and various sizes of equipment are available for small or large areas. "Ritecure" is in use in temperatures of extreme degrees all over the world, and is being extensively used by leading Engineers and Contractors in this country for concrete runways, roads, and other forms of concrete work, including precast concrete products.

"Ritecure" is backed by a highly developed Technical Service with an extensive experience in concrete curing, so that its correct and economical use is assured on all forms of concrete work.

The illustration above shows its application in this country on a concrete runway where 1½ million yards of concrete were laid and cured with "Ritecure". The 20-feet wide bays were sprayed without the operators or equipment touching the newly-laid concrete.

Fully illustrated details and technical information are available on application to:

**STUART B. DICKENS** 36 VICTORIA STREET, LONDON, S.W.1  
OLD MILTON STREET, LEICESTER (Works)

# SCB

*the originators of*

## ADJUSTABLE TUBULAR STEEL PROPS

**FOR HIRE OR SALE**

*The ideal Prop, simple, robust and fully adjustable. Made in two sizes.*

	CLOSED	FULLY EXTENDED	WEIGHT
1	6' 0"	10' 3"	56 lbs.
2	10' 2"	15' 0"	74 lbs.

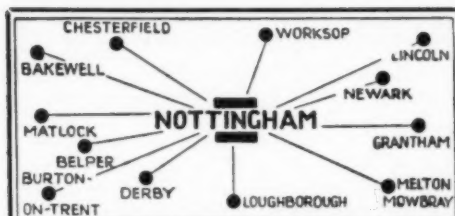
**SCAFFOLDING (GREAT BRITAIN) LTD.**  
**MITCHAM, SURREY**

Telephone: MITCHAM 3400 (18 lines). 'Grams: SCAFCO, MITCHAM



Branches in the following Cities and Towns :  
 ABERDEEN • BIRMINGHAM • BOURNEMOUTH  
 BRIGHTON • BRISTOL • CAMBRIDGE • CAR-  
 DIFF • DOVER • DUBLIN • DUNDEE • EDIN-  
 BURG • EXETER • GLASGOW • HULL • LEEDS  
 LIVERPOOL • MANCHESTER • NEWCASTLE  
 NOTTINGHAM • OXFORD • PLYMOUTH  
 PORTSMOUTH • SOUTHAMPTON • STOKE-ON-  
 TRENT • SWANSEA





## Trent Gravels

**10,000 tons per week**

*Washed & Crushed  $1\frac{1}{2}$  in. to  $\frac{1}{4}$  in.*

We are the leading suppliers of high-class concrete aggregates in the area shown above. Prompt deliveries guaranteed and keen competitive prices quoted. Send for samples and prices.

**TRENT GRAVELS LTD**

**ATTENBOROUGH**

**NOTTS**

Telephone: Beeston 54255.

## Exhibition of Prestressed Concrete.

At the Exhibition of Industrial Power at the Kelvin Hall, Glasgow, there are shown prestressed concrete structural members and models showing the methods of manufacture of prestressed concrete and the plant used by various firms who specialise in prestressed concrete. The exhibition has been organised in connection with the Festival of Britain, and remains open until August 18.

Specialities Allied to—

### CONCRETE & BUILDING PRODUCTS

including Accelerators, Retarders, Hardeners, Waterproofers, Oilproofers, Cement Paints, etc.

For full particulars please write

### ALLIED BUILDING COMMODITIES

**LITTLE ROYD, HUDDERSFIELD.**

# POWER BAR CUTTERS

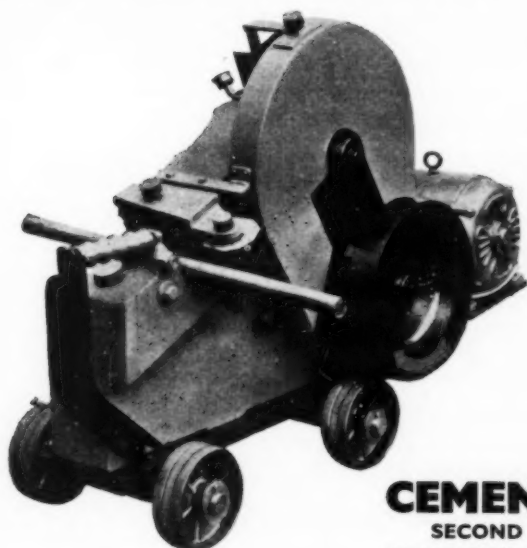


Illustration shows our BRRL.50A Model High-Speed Shearing Machine for cutting Mild Steel Rods up to 2-in. diameter. This machine, of robust construction yet still portable in view of its compact arrangement, is powered by electric motor and self-tensioning Vee-belt drive. The moving blade is in continuous action and makes 28 cuts per minute; 2-in. diameter mild steel bars require one cut only. The static blade is housed in a specially-designed seating which spreads the shearing thrust over a wide area, thus reducing wear and considerably lengthening the life of the machine.

## CEMENT & STEEL, LTD.

**SECOND AVENUE, CHATHAM, KENT**

Telephone: Chatham 45580. Telegrams & Cables: Cembelgi, Chatham

## Prestressed Concrete Bridges in the U.S.A.

THERE are at present at least three prestressed concrete bridges either complete or in course of construction in the United States. The first to be put into service is a road bridge in Tennessee. The first to be commenced is the Walnut Lane Bridge, Philadelphia, having a span of 155 ft., the design, construction, and testing of which is described fully by Professor Magnel in his book "Prestressed Concrete". The third is a footbridge in California which, together with the bridge in Tennessee, is described in the following abstract from recent numbers of "Engineering News-Record".

### Road Bridge in Tennessee.

This bridge has two simply-supported end spans of 20 ft. and a central span of 30 ft. The road is 19 ft. wide. The end and intermediate supports are timber piled frames. Each span comprises fifteen 16-in. by 12-in. prestressed beams side by side, and cast-in-situ top slab, kerbs, and filling between the beams. The beams, which are held together by transverse cables, are composed mostly of standard machine-made 8-in. by 16-in. by 12-in. concrete blocks, with special end-blocks in which the longitudinal wires are anchored, and depresser blocks which

hold the wires in place vertically. The standard blocks have three rectangular openings through which the wires pass, and a bottom flange that projects about 1 in. beyond the sides. The blocks and the mortar between them have a compressive strength of 3750 lb. per square inch.

The beams, of which there are 45, were made in a factory. One beam was assembled at a time on a table, starting with an end-block with the wires attached. One wire is provided in each 20-ft. beam and two wires in each 30-ft. beam. The wires are composed of seven strands each, galvanised for protection against corrosion, and are  $\frac{3}{16}$  in. diameter. A fitting is attached to each end and a threaded stud is inserted in the fitting. Turning a nut on the stud adjusts the tension. The nut bears against a 5-in. by 6-in. steel plate  $\frac{3}{4}$  in. thick, which distributes the pressure over the end-block. The blocks, the ends of which were mortared, were strung on the wires and pressed together. The other end-block was then attached and an initial tensile force of 10,000 lb. per wire applied; this is equivalent to an average compressive stress in the concrete of about 100 lb. per square inch for single-wire beams. The next day

### JUST PUBLISHED

## DESIGN OF PRISMATIC STRUCTURES

By A. J. ASHDOWN

Describes simple methods of designing roofs and other structural parts composed of vertical, sloping, and horizontal reinforced concrete slabs. Solutions by relaxation and other methods clearly explained.

I.—Prismatic Structures of One Span.—Types. Stabilising forces. Shearing and principal stresses. Examples (using relaxation method). Roof with unsupported ties (moment-balance method of calculating transverse moments). Roof with supported ties. Anisotropic structures. Openings in roof.

II.—Multiple-Bay Structures.—Pitched roof of two bays analysed by an approximate method and by a theoretical analysis as a statically-indeterminate structure. Tensile stresses in thin slabs. Double-trough bunker.

III.—Continuous Structures.—Formulae. Roof continuous over three spans. Supports of roof (column analogy and combined bending and direct force).

IV.—Structures with Sloping Ends.—Symmetrical and unsymmetrical structures. Multiple roofs.

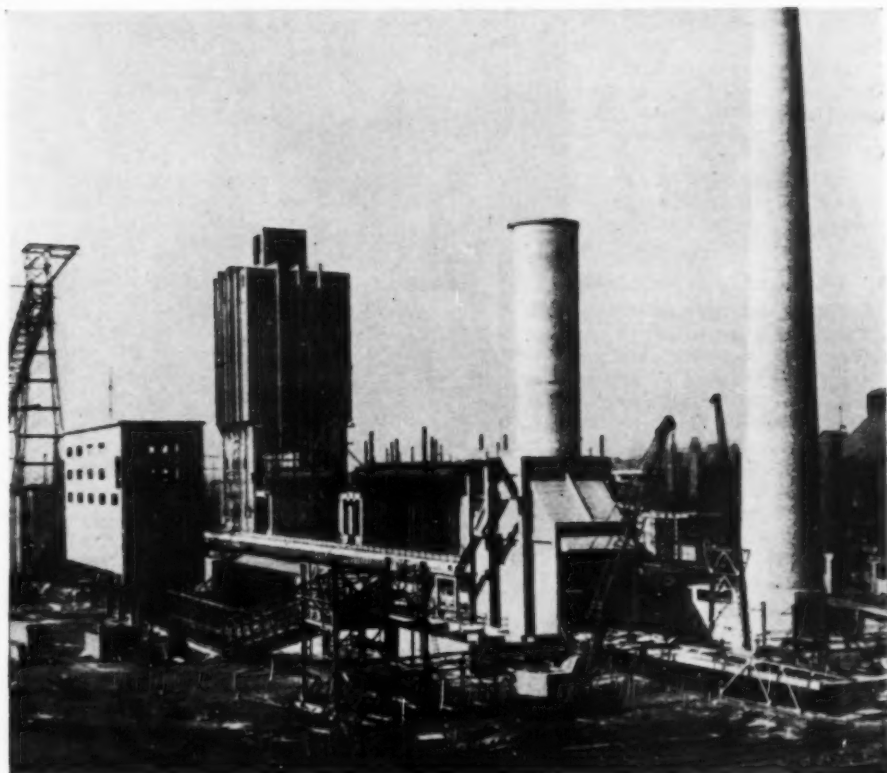
V.—Miscellaneous Problems.—Effect of friction on supported ties. Transverse stiffeners.

64 pages. 36 illustrations. Price 8s. ; by post 8s. 6d. 1-85 dollars in Canada and U.S.A.

### A NEW "CONCRETE SERIES" BOOK

CONCRETE PUBLICATIONS LIMITED, 14 Dartmouth Street,  
London, S.W.1, England





A general view of the new coking plant at the East Greenwich Gasworks, designed and constructed by Messrs. Simon-Carves, Ltd., for the South Eastern Gas Board. All the structures shown are supported on Simplex Concrete Cast-in-Situ Piles.

## **SIMPLEX CONCRETE PILES LTD.**

25 BRECHIN PLACE,

SOUTH KENSINGTON,

LONDON, S.W.7

Telephone: Fremantle 0035-8

---



## STEEL REINFORCING BARS

"Stribar" Reinforcement is the backbone of multitudinous ferro-concrete structures. The "Stribar" service of ready-for-use reinforcement, cut to length and, if required, hooked and bent, is being maintained as far as present abnormal conditions permit. Deliveries from warehouse stocks in the London area cannot always be guaranteed, but by telephoning Sloane 4533 the latest position can always be ascertained.

THE UNITED  
**STEEL**  
COMPANIES LTD

### UNITED STRIP & BAR MILLS · THE ICKLES · SHEFFIELD

Branch of The United Steel Companies Limited

Telephone : Sheffield 41011 · Rotherham 5421

LONDON : 8-10 Grosvenor Gardens, S.W.1

Telephone : Sloane 4533

the final force of 26,000 lb. per wire was applied by an hydraulic jack, and is equivalent to about 125,000 lb. per square inch in the wires, that is, less than the stress at which creep occurs. In course of time the tensile stress may decrease to 105,000 lb. per square inch, producing an average compressive stress in the concrete in a single-wire beam of about 230 lb. per square inch. At mid-span the compressive stress at the bottom of a prestressed single-wire beam is about 470 lb. per square inch while carrying its own weight, and in a double-wire beam up to 940 lb. per square inch. There is no stress in the top of the beams under this condition.

The beams were put in place by a crane, those for one end span being placed first. Wooden planks 3 in. thick were placed on these beams and the crane travelled on them to erect the beams for the middle span. The crane then moved on the middle span to place the beams for the other end span. As the beams were placed, seven-strand wires for the

transverse prestressing were threaded through holes in the blocks. When the cast-in-situ slab had been placed and had hardened, each of the transverse wires was tensioned to 26,000 lb. with a jack.

The beams were assembled and prestressed in three days, and the slab and kerbs were cast in one day. Rapid-hardening Portland cement was used, and the bridge was put into service two weeks after erection started.

#### **Footbridge near Los Angeles.**

A prestressed concrete footbridge of 110-ft. span is in course of construction near Los Angeles. The 5-in. deck slab is 8 ft. wide and is designed for a live load of 55 lb. per square foot. The two simply-supported girders, projecting 4 ft. above the slab, are 5 ft. 8 in. deep, the webs being 10 in. thick and the top flange 20 in. wide and 9 in. deep. Each girder is prestressed with 136 wires of 0.2 in. diameter. The initial stress in the wires, which are stretched five at a time, is

## **STRONGER CONCRETE PNEUMATICALLY APPLIED . .**

**QUICKER AND CHEAPER  
BY THE**

## **PNEUMATIC CONCRETOR**

Air-applied concrete gives greater strength. It is absolutely impervious to moisture, and bonds so tightly as to act as an original part of the structure.

The Pneumatic Concretor applies concrete by a "shooting" action. Perfect density, greater strength, minimum water content, and low cost application are a few of the features of this unit. Ideal for steel work, masonry, timber, against corrosion, salt water, chemicals, etc. Send for leaflet to-day.



**BOULDER EQUIPMENT LTD.**

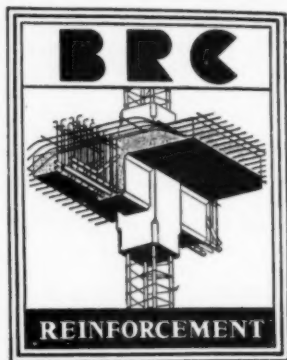
18 HIGH STREET, BARNET, HERTS. PHONE: BARNET 4141

★ CABLES: BOULDER, BARNET

120,000 lb. per square inch. The working compressive stress in the concrete is 1700 lb. per sq. in. and the final tensile stress in the wires is 102,000 lb. per square inch. The method of stretching the wires is as follows.

Five wires are threaded through holes in a 1-in. by 4-in. steel block  $3\frac{1}{2}$  in. thick, and  $\frac{5}{8}$ -in. washers are slipped over them. A button-head is attached to the end of each wire. This fastening is expected to yield not more than  $\frac{1}{8}$  in. when the force in the wire is  $1\frac{1}{2}$  times the force at the working load. The group of wires is then inserted in a metal sheath to prevent bond with the concrete, and placed in the shuttering. The concrete is then placed and, when it attains a strength of 5000 lb. per square foot (in about 28 days), jacks bearing against a  $6\frac{1}{2}$ -in. by 20-in. steel block 3 in. thick are used to stretch the wires. When all the groups of wires are stretched, the space around them is grouted under pressure through 1-in. holes in the jacking blocks. The girders, each of which weighs about 50 tons, were precast at the site, a method which re-

duced the cost of the shuttering compared with cast-in-situ construction, and enabled the girders to be made during the winter when falsework in the river was not practicable. Each girder contains 50 cu. yd. of concrete and 7000 lb. of steel, compared with 88 cu. yd. of concrete and 40,000 lb. of steel required for an ordinary reinforced concrete bridge.



## STEEL TRENCH SHEETING

(Regd. design  
No. 850839)

**Prompt  
Delivery**

For the temporary lining of trenches and foundations. *Prices and full particulars on application to:—*

**DORMAN LONG & CO. LTD., SHEET DEPT.  
AYRTON WORKS, MIDDLESBROUGH**

London Office: Terminal House, 52 Grosvenor Gardens, S.W.1

# DORMAN LONG

WINGET TECHNIQUES IN CONCRETE PRODUCTION

## A one man operated Weigh Batching Plant

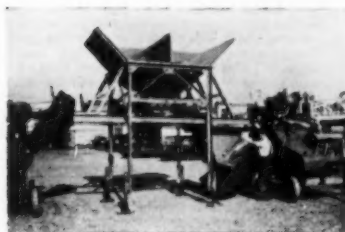
### THE WINGET PORTABLE TWIN TROLLEY BATCHER



1. Towed straight on to job by small lorry.



2. Trailer quickly disconnected and can be used for other jobs.



3. Weigh Batcher supported on overhead track. Centre section incorporated in the weigh gear. Manual indicator type beam box includes 2 weigh beams of 2,000 lb. capacity each.



4. Two 21/14 Mixers can be charged with weighed materials. Two-compartment storage bin has 8 cu. yd. capacity.

**T**HIS new Winget device extends still further the applications of scientific weigh batching. Weighing only two tons, it can be towed straight on to the job by small lorry, set up in 30 minutes, and put to work on supplying weighed materials to 2 mixers up to 21/14 capacity. The two-compartment storage bin of 8 cu. yd. capacity has sufficiently low headroom to allow direct charging by mechanical shovel or equal. While the plant is in use, the trailer type chassis can be put to other uses. Details of this and other Winget Batching Plant will be gladly sent on request. Ask for the Winget Civil Engineering Catalogue (Publication No. 100).

**WINGET WEIGH BATCHING PLANT** and other Engineering Equipment is supplied for such projects as:—Owen Falls (Uganda), Venda Nova Dam, Grimsel Dam, Claerwen Dam, Maraetai Dam, Prescott Reservoir.



# Winget

CONCRETE PLANT SPECIALISTS

WINGET LTD ROCHESTER,  
KENT ENGLAND

Tel: Strood 7276 (5 lines) Telegrams Wingetium Rochester

## MISCELLANEOUS ADVERTISEMENTS.

**Situations Wanted, 3d. a word: minimum 7s. 6d. Situations Vacant, 4d. a word: minimum 10s. Other miscellaneous advertisements, 4d. a word: 10s. minimum. Box number 1s. extra.**

**Advertisements must reach this office by the 23rd of the month preceding publication.**

## SITUATIONS VACANT.

**SITUATION VACANT.** Midland precast concrete works require assistant, 24-30, with initiative and drive, to take charge of section of production. Previous knowledge preferable, but not essential. Good prospects of advancement. Accommodation may be available. Staff pension scheme. Box 2461, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

**SITUATIONS VACANT.** The Liversedge Reinforced Concrete Engineering Co., Ltd., Liversedge House, John Adam Street, London, W.C.2, invite written applications for the following positions in their London and Brighton offices: (i) Designer and designer-draftsmen with particular experience in arch shell roof design and detailing. (ii) Detailers with design knowledge, and draughtsmen for work on all types of reinforced concrete structures. (iii) Keen juniors with technical ability for training. State full details of qualifications, age, and summary of experience.

**SITUATIONS VACANT.** Reinforced concrete designers and detailers required. State experience and salary required. TWISTEL REINFORCEMENT, LTD., Alma Street, Smethwick, Staffs.

**SITUATIONS VACANT.** Designer/draftsmen required in Designs Branch of Air Ministry Works Department. Candidates should have experience in actual design of either reinforced concrete or structural steelwork. Vacancies are in London. Salaries are on ranges up to £675 p.a. with starting pay dependent upon age, qualifications, and experience. Applications stating age, qualifications, previous appointments (with dates), should be sent to AIR MINISTRY, DIRECTORATE-GENERAL OF WORKS (W.9.), Bush House (S.E. Wing), Strand, London, W.C.2, from which address further details may be obtained.

**SITUATION VACANT.** Civil engineering assistant capable of designing and detailing reinforced concrete structures required at once by Edinburgh firm of consulting engineers. Details of salary required, qualifications, and experience to Box 2475, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

**SITUATION VACANT.** Wanted. Reinforced concrete designer, particularly with experience in the design and detailing of shell concrete roofs, for South Africa. Excellent prospects with contract. Replies to Box R.C.301, 10 Hertford Street, London, W.1.

**SITUATION VACANT.** Wanted for Consulting Engineer's office, experienced detailer for reinforced concrete work. Salary according to age and experience. Applicants, who should be between 20 and 30 years of age, should apply in writing to F. J. SAMUEL, 8 Hamilton Place, London, W.1, giving details of qualifications, experience, etc.

**SITUATION VACANT.** Works manager required to take charge of modern precast concrete factory in Midlands. Experience of Triano block machines and up-to-date precast methods essential. Good salary and bonus, with excellent prospects for live and conscientious man. Subject to trial period, suitable applicant may take up shares in the company with view to an ultimate directorship. Write in confidence in first instance, with fullest details. Box 2474, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

**SITUATIONS VACANT.** Braithwaite & Co., Engineers, Ltd., Dorland House, Regent Street, London, S.W.1, require for London design department one senior and two junior reinforced concrete designer-draftsmen experienced in preparation of detailed designs and drawings of reinforced concrete structures and buildings. Apply by letter stating age, qualifications, experience, and salary required to Box J867, c/o Streets, 110 Old Broad Street, London, E.C.2.

## MINISTRY OF WORKS

Drawing office staff are required in the Structural Engineering Division, for duty in London, Risley (Warrington) and principal provincial cities. Hostel accommodation is available for men at Risley.

**LONDON SALARY:** STRUCTURAL ENGINEERING ASSISTANTS: £320-£545 per annum. Minimum is linked to age 21, with £20 additional for each year above, up to a maximum entry rate of £480 per annum.

**LEADING STRUCTURAL ENGINEERING ASSISTANTS:** £570-£675 per annum. Rates outside London are slightly lower.

Applicants should be experienced in design and/or detailing of either reinforced concrete or structural steelwork. The work is varied and not confined to standard schemes.

Although these are not established posts, some of them have long term possibilities, and competitions are held periodically to fill established vacancies.

Apply in writing, stating age, nationality, full details of experience, and locality preferred, to:—

**CHIEF STRUCTURAL ENGINEER, W.G.10/BN., MINISTRY OF WORKS, Abell House, John Islip Street, London, S.W.1.**

**SITUATIONS VACANT.** Reinforced concrete designers and detailers wanted for Southern Rhodesia and Union of South Africa. Candidates should have had at least five years' experience of competitive designing. Free passages. Salary according to experience and qualifications. Details in confidence to Box "MA/86," c/o 95 Bishopsgate, London, E.C.2.

**SITUATIONS VACANT.** Experienced designers required for East Africa by long-established company of reinforced concrete specialists employed primarily on design of commercial structures. Unmarried men preferred. 4½-year contract (mutually renewable) with paid passages. Salary commensurate with experience and qualifications. Write Box "MA/84," c/o 95 Bishopsgate, London, E.C.2.

**SITUATIONS VACANT.** Applications are invited for senior and junior appointments as design engineers engaged on prestressed and reinforced concrete structures. Knowledge of prestressed concrete is desirable and of reinforced concrete essential for the senior positions. Applications stating age, qualifications, experience and present salary should be marked "Design" and addressed to STRESSED CONCRETE DESIGN, LTD., Lynton House, 54 South Side, London, S.W.4.

**SITUATION VACANT.** A well-known firm of heavy industrial plant engineers, situated near Manchester, requires a reinforced concrete designing engineer with experience in all types of industrial structures. The position is a permanent one and progressive. A pension fund is in operation. Five-day week. The commencing salary will be between £800 and £1,000 a year according to ability. Apply briefly stating previous employers, with dates and positions held, to Box 2476, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1, and quoting reference PE/707.

**SAMUEL WILLIAMS & SONS LTD., Dagenham Dock Estate, Essex,** invite applications from civil engineering and architectural assistants for the following posts:—

1. **Reinforced Concrete Designer** with considerable experience as designer-draftsman. Experience of marine structures and steelwork would be advantageous.
  2. **Civil Engineering Draughtsman** with general civil, structural and building experience.
  3. **Junior Civil Draughtsman**, aged about 22, with completed National Service. (Opportunity given to continue technical education.)
  4. **Architectural Assistant**, good draughtsman with knowledge of building construction and specification, and preferably experience of industrial work.
- Good salaries, conditions and opportunities for suitable men; pensionable appointments and great variety of work. Assistance may be given in obtaining a house, if required. Apply in writing, with details of age, training, and experience to the PERSONNEL MANAGER.

(Continued on facing page.)



### British Standard for Concrete Mixers.

BRITISH Standard No. 1305 (1946), "Batch Type Concrete Mixers", now includes details of a 2 cu. ft. tilting mixer. The ratio of the volume of the drum to the nominal capacity must be not less than 2.53 nor more than 3.18. A tank for measuring water is not necessary if a power-loader is not fitted, but otherwise the tank must have a capacity of at least 2½ gallons and be capable of measuring and discharging automatically ½ gallon of water. The minimum height above the ground of the discharge point of a portable 2 cu. ft. mixer is 2 ft.

(Continued from facing page.)

**SITUATIONS VACANT.** THE DOCKS AND INLAND WATERWAYS EXECUTIVE invite applications for the following temporary positions in the Office of the Chief Engineer for Docks, Hull: One senior reinforced concrete designer; Two reinforced concrete detailers; Two civil engineering draughtsmen. The salary for the positions will be from £550/£680 per annum but additional allowances above the scale may be given for suitably qualified and experienced applicants. The work in the first instance will be the design and preparation of contract drawings, specification, and bill of quantities for a deep water tidal wharf of reinforced concrete to carry travelling cranes and railway tracks. The senior designer should have initiative and be able to take charge with a minimum of supervision; he should preferably have a knowledge of prestressed concrete. Experience of associated harbour and dock work would be an advantage for all the appointments. Whilst the positions will be temporary, there will be a prospect of permanency. Applications stating age, qualifications, experience, present position, and salary, etc., should be sent to reach the SECRETARY, 22 Dorset Square, London, N.W.1, not later than 25 June, 1951.

**SITUATION VACANT.** Well-known London firm specialising in hollow-tile floor construction require an assistant (to their chief engineer) to take charge of and control drawing-office. Applicants must have knowledge of reinforced concrete frames and steelwork and various forms of construction, be familiar with drawing-office practice and site work, and possess experience in the preparation of designs, calculations, and detailing. Write fully experience, technical qualifications, and salary required. Box 2478, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

**WANTED.** Architectural draughtsman. Good 'bus and rail service. Canteen facilities. Applicants should state age, experience, and salary required in confidence to THE SECRETARY, THE CROFT GRANITE, BRICK AND CONCRETE CO., LTD., Croft, near Leicester.

### SITUATIONS WANTED.

**SITUATION WANTED.** B.Sc., A.M.I.Struct.E., 36, going to seed, seeks change. Experience in reinforced concrete frames, reservoirs, dams, sewage and water, pumping stations, etc. Starting salary £800. Box 2473, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

**SITUATION WANTED.** Reinforced concrete designer with experience is able to undertake part-time work at home for consulting engineers. Design and detailing of all types of reinforced concrete structures. Write giving your requirements to Box 2477, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

### FOR SALE.

**FOR SALE.** New 2½-in. bore rubberised canvas suction hose with coiled rust-proofed wire insert in 12 ft. and 6 ft. lengths. 10s. and 5s. per length, cart. paid. Small orders C.W.O. please. WOODFIELD & TURNER, Burnley. Telephone: Burnley 3065.

**FOR SALE.** Sacks, bags, and curing cloths for sale. You want the best type and quickest delivery. Write JOHN BRAYDON, LTD., 26 The Highway, London, E.1. Telephone: ROYal 1044.

June, 1951.

No timber is required, no carpenters' workshop on site. No obstruction beneath. For solid Concrete or Hollow Tile floor and roof construction. Instantly-adjustable up to 15 ft., adaptable for larger spans. Invaluable also for repair work. On hire from stock. Write or 'phone.

**TRIANCO LTD. (D. 26)**

Imber Court, East Molesey, Surrey

'Phone: Emberbrook 3380 (4 lines)

# DATA FOR PRICING REINFORCED CONCRETE.

## Materials.

(Delivered in London area.)

**AGGREGATES** (per cu. yd.).—Washed sand, 17s. Clean shingle:  $\frac{3}{4}$  in., 15s. 2d.;  $\frac{1}{2}$  in., 17s. 6d. Thames ballast, 15s. 9d. Broken brick,  $\frac{3}{4}$  in., 17s. 6d.

**CEMENT** (per ton, delivered at Charing Cross).—Portland cement, 6 tons and upwards, 91s. 1 ton to 6 tons, 96s. Paper bags and non-returnable jute sacks included. Rapid-hardening Portland, 6s. above ordinary Portland.

Aquacrete and 417, 32s. 6d. above ordinary Portland; paper bags included. Colorcrete (buff, red, and khaki), in 6-ton loads, 132s. 6d.; paper bags included. Snowcrete, £12 8s. 6d., inc. paper bags. "Super-Cement," 31s. 6d. per ton above ordinary Portland cement; bags included. High-alumina cement, 1 ton and upwards, 247s. 6d. per ton; paper bags 17s. 6d. per ton extra.

Snowcrete paint, 56s. per cwt. inc. containers.

**SHUTTERING**.—For prices of timber, refer to S.R. & O., 1949, No. 1079 (price 1s. 1d.) and No. 94 (price 5d.) issued by H.M. Stationery Office.

**REINFORCEMENT**.—Mild steel round bars (per cwt.):  $\frac{1}{2}$  in. to 2 $\frac{1}{2}$  in., 28s. 2d.  $\frac{3}{4}$  in. to  $\frac{1}{2}$  in., 29s.  $\frac{1}{2}$  in., 29s. 8d.  $\frac{3}{4}$  in., 31s.

## Materials and Labour.

(Contracts up to £5000, Inc. 10 per cent. profit.)

**PORTLAND CEMENT CONCRETE, 1 : 2 : 4**.—Foundations, 2s. 2d. per cu. ft. Columns, 2s. 5d. per cu. ft. Beams, 2s. 5d. per cu. ft. Floor slabs 4 in. thick, 6s. 10d. per sq. yd.; Do., 5 in., 8s. 7d.; Do., 6 in., 10s. 3d.; Do., 7 in., 12s. Walls 6 in. thick, 10s. 3d. per sq. yd. Add for hoisting 3s. 6d. per cu. yd. above ground floor level. Add for rapid-hardening Portland cement 2s. per cu. yd.

**REINFORCEMENT**.—Mild steel round bars, including cutting, bending, fixing, and wire (per cwt.)— $\frac{1}{2}$  in. to  $\frac{1}{2}$  in., 48s. 6d.  $\frac{3}{4}$  in. to  $\frac{1}{2}$  in., 43s. 6d.  $\frac{1}{2}$  in. to 2 $\frac{1}{2}$  in., 42s.

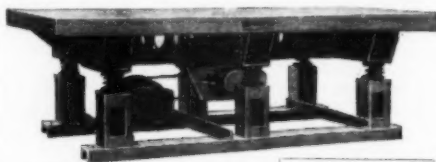
**SHUTTERING AND SUPPORTS**.—Walls, 155s. per square. Floors (average 10 ft. high), 160s. per square. In small quantities, 1s. 8d. per sq. ft. Columns, average 18 in. by 18 in. (per sq. ft.), 1s. 8d.; in narrow widths, 2s. Beam sides and soffits, average 9 in. by 12 in. (per sq. ft.), 2s.; in narrow widths, 2s. 2d. Raking, cutting, and waste, 5d. per lin. ft. Labour on slays, 3d. per lin. ft. Small fillets to form chamfers, 6d. per lin. ft.

## Wages.

The rates of wages on which the above prices are based are: Carpenters and joiners, 3s. per hour (carpenters 2d. a day tool money); Labourers, 2s. 6d.; Men on mixers and hoists, 2s. 7d.; Bar-benders, 2s. 8d.

This column is specially compiled for "Concrete and Constructional Engineering," and is strictly copyright.

# DEFINITELY GIVES YOU STRENGTH CONCRETE



**JOHNSON**

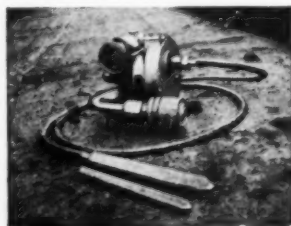
**AVOIDS  
segregation**

# 'MAXIBRATER'

## VERTICAL VIBRATION

**Cruciform design** of table top ensures equal vibration over whole area. Rugged construction for long and continuous service with minimum upkeep costs.

**Ave. compressive strength 6,000 lb. per sq. in.** in weekly independent tests over 12 months. Takes any precast work up to 10 ft. lengths. See Folder X/24.



Extremely  
**EASY to  
WORK**  
on your  
close or  
intricate  
reinforce-  
ment.

# JOHNSON Internal Concrete VIBRATORS

Illustrated is **PETROL FLEX DRIVE** [one of two types] Johnson Internal Vibrator. Vibration is confined to the "spade," thus ensuring long life of motor; imposes no strain on operator; all mechanical parts greased and sealed for life. Also Electric Flex Drive and Electric Stiff Shaft models. See Folder V24.

● May we send you full details of

**JOHNSON CONCRETE VIBRATING MACHINES:** Tables, Internal Vibrators, Platform Vibrators, Screened Units for better concrete road-making. **WRITE TODAY. TERMS CAN BE ARRANGED.**

**C. H. JOHNSON**  
(MACHINERY) LTD.

**X/V/24, ADSWOOD RD., STOCKPORT**

or contact our nearest representative:

**LONDON:** Pollards 3133. **BRISTOL and SOUTH WALES:** (Bristol) Lulgate 277. **NOTTINGHAM:** Bulwell 71135. **MIDLANDS:** 40 Omar Road, Stoke, Coventry. **LANCE:** 1 Gatley 4494. **YORKS NORTHUMBERLAND and DURHAM:** Otley 2463. **NORTH WALES and SHROPSHIRE:** Chester 22937. **SCOTLAND:** 61 Hillington Road, Glasgow, S.W.2.

602a



## SULPHATE-RESISTING PORTLAND CEMENT

This Blue Circle Product has been specially introduced for concrete which is subject to the destructive action of soluble sulphates, e.g. in sea water, some ground waters and certain clay soils. Provided due regard is paid to producing good dense concrete, Sulphate-Resisting Cement will make it proof against concentrations of up to 2 per cent. sulphur trioxide in soil and up to 500 parts per 100,000 in water (0.5%)

### **S.R.P.C. POSSESSES ALL THE DURABILITIES AND**

### **STRENGTH CHARACTERISTICS OF PORTLAND CEMENT**

*A satisfactory interim report has been received from the Director, Building Research Station. Copies of the Summary of this interim report will be forwarded on application.*



**THE CEMENT MARKETING CO. LTD**

PORTLAND HOUSE · TOTHILL STREET · LONDON · SW1

or G. & T. Earle Ltd. · Wilmington · Hull

The South Wales Portland Cement & Lime Co. Ltd. Penarth. Glam



Every  
well-planned road  
laid in  
**Reinforced Concrete**  
is a step nearer  
to national  
highway perfection

**BRC**

REINFORCEMENT FOR ROADS

**THE BRITISH REINFORCED CONCRETE ENGINEERING CO. LTD., STAFFORD**

*London, Birmingham, Bristol, Leeds, Leicester, Manchester, Newcastle, Sheffield, Cardiff, Glasgow,  
Dublin, Belfast*

M-W.596